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One of the results that has followed the construction of interurban railway lines has been the extension of electric lighting into a large number of places which were not provided with it before, and the taking over of contracts in many instances for the lighting of small towns by the railway companies. It is particularly easy, where polyphase generation is employed, to install apparatus operated by the feed current for the railway lines to light such towns, and the economies resulting from the generation of current in bulk and its transmission at high pressure enable such companies often to undertake local lighting in small places profitably at a lower cost than would be possible for a local lighting corporation. This has been especially noticeable in the Middle West where interurban lines abound, and is of considerable interest as showing the existence of a kind of by-product which may be disposed of by the generating plants for such railways.

THE GLASGOW EXHIBITION.

On other pages of this issue Mr. Sydney F. Walker describes at length and with a great wealth of illustration the electrical features of the exhibition at Glasgow, Scotland. There has been no important exhibition in Great Britain before for several years, and at this one the engineering work of the numerous manufacturing concerns of that country is shown for the first time in its modern form.

There is much of interest to American electrical engineers in the apparatus exhibited at Glasgow this year. The major differences between standard British and American practice are becoming smaller and smaller as time goes on, while, however, different conditions surrounding both designs of manufacture have led to a certain differentiation which of itself is extremely interesting. It is curious to note that, to-day, it would be hard to judge from an inspection (if the name-plates were removed) whether a standard alternating dynamo, for example, was made in England, Germany or the United States. The wide differences which once marked the designs for apparatus in these countries have disappeared, leaving only those peculiarities which are imposed by different conditions of use and certain variations due to national taste—something which, though elusive and incapable of definition, yet certainly exists. In engineering, as in other things, there is a wide opportunity for the display of taste, while fashion holds more or less sway. In former years the difference in appearance between British and American apparatus was very much greater than it is now, and whether this is due to the tastes of designers coming more nearly together or to the survival of the fitter designs and the widespread publication of the results of experience is hard to determine.

The exposition has been very successful and Mr. Walker's article shows it to be worthy of an interested study.

CENTRAL STATION DESIGN.

Probably the most important electrical apparatus is the central station; for it is just and proper to consider the central station as a unit and not simply as a collection of various apparatus as has too often been done in the past.

The function of a central station is to generate electricity in a marketable form, using either falling water or the energy of burning coal as its prime motive power, and to accomplish this result with a maximum of simplicity and efficiency. In the early days of the art practically all that was considered in planning a central station was the housing of a certain number of dynamos adapted to give the particular kind of current desired and the connection with them of engines or water-wheels of a power sufficient to keep them moving. It was not until some time after the inception of central station engineering that it was seen that the whole institution must be considered as a unit in order to attain the best possible result.

Differing as they do in size and in nature of service central stations are naturally widely divergent in type. Their earliest development consisted of means for supplying small and concentrated areas of distribution with electricity at constant potential and under comparatively low pressure. In their modern evolution central stations are required often to distribute over large and increasing areas and the demands made upon them are almost as diverse as the conditions under which they are operated.

Take, for example, the station in a large city where a daylight load of motors and lights may be had and where the evening peak of the load curve is not very considerable. In such a case it is probable that the distribution area will be relatively small and the concentration of power supply will be relatively very great. For this particular service stations of high efficiency have been devised in the past em-

ploying direct-current generation and distribution on a three-wire system at comparatively low tension. But it was soon seen in the development of electricity supply in cities that this system was bound within narrow and rigid limitations. In order to supply such a district as the Metropolitan area of New York city, for example, it was perfectly evident that no single station could possibly undertake the task employing direct generation at about the voltage employed for lamps and motors.

In consequence the alternating system, first introduced some seventeen years ago, rapidly grew in favor, especially in places where the area of distribution was relatively large and the condensation relatively small. Single-phase systems were laid down with more or less efficient secondary apparatus to supply such areas, but experience in operation proved that these systems would not compete in crowded districts successfully with the low-tension direct-current three-wire installations. Concurrently with the problems presented by the distribution of current for incandescent lighting or motor purposes over areas of considerable extent was felt the difficulty of efficient generation of current for street lighting where arcs are employed.

Perhaps the greatest desideratum which has been hoped for by large central stations for several years past was an efficient method of arc current generation. Owing to the conditions surrounding the employment of direct current for series arc lamps the generating machines were limited to small sizes—far too small for direct connection. What was urgently desired for some time was a design of arc light generator capable of being made in large sizes. So long, however, as it was necessary to use direct current for arc lamps it was manifestly impossible to make such a generator unless the lamps were burned from it in multiple arc. The expense of a multiple arc system of wiring was naturally so great that this method was justly regarded as impracticable, except where it could be practised upon systems already installed and laid down for incandescent lighting. Among the numerous methods that were tried to obviate this difficulty may be mentioned that employed in the Boston Electric Light Company's fine station, where a power transmission of about fifty feet is employed, the large engines of the station being direct coupled with polyphase generators supplying incandescent lights on their various phases and arc generators being driven by induction motors operated from the primary polyphase current.

It was not long, however, after the introduction of the enclosed arc lamp before it was found that alternating current could be used with exceeding satisfaction in this type of lamp and consequently the whole problem of supplying arc lights over widely scattered territory could be approached from a new point of view. As a matter of fact the series enclosed alternating arc systems have made possible the desire of station managers to operate large machines direct coupled for arc lighting, for these lights may be burned with entire satisfaction from any generator whose frequency is sufficiently high, whether it be single-phase or polyphase in character.

Now that alternating-current motors have been brought to a high state of perfection and efficiency and methods for conversion from alternating current to direct have been thoroughly worked out and well established in practice, there remains practically no longer the necessity for operating direct-current stations except for the service of railways in condensed traffic areas. As a consequence of these facts practically all of the modern stations of large size, intended to supply considerable amounts of power over areas of such large extent, embody some form of polyphase generation, either with or without substations for conversion to direct current. It should be borne in mind that the latter are necessary only where railways are to be operated. Motors up to any reasonable size are perfectly practicable upon polyphase circuits and, despite the contention that has lately been waged among numerous eminent engineers as to the inherent values of the three-phase motor, the impression is widely existent that the polyphase motor has come to stay and will represent an exceedingly important factor in electrical extension.

Recent discoveries in translating apparatus for lighting, of which the Nernst lamp is the most prominent, have also greatly strengthened the conviction that the variety of current best adapted for general work is alternating. If it should happen that these lamps should take a prominent position in the industrial field, then it is almost certain that direct-current methods of lighting will disappear in favor of the alternating variety.

Practically the chief stronghold of the direct-current system is the ability to use storage batteries in connection with it and thus to equalize the load curve. But it should not be forgotten that the storage battery is almost equally applicable to an alternating system of distribution through the agency of synchronous converting apparatus adapted for reversible operation.

It seems, therefore, from all these considerations that central station design in the future will tend more and more toward the employment of polyphase apparatus, with such occasional conversion apparatus as may be necessary where direct current is absolutely necessary. Naturally the tendency will be to the employment of the largest possible units in such apparatus, while it is believed that the increasing areas of supply will demand higher and higher pressures until some working standard is found, which probably may not be far short of the highest pressures at present employed.

THE FIREMAN.

One of the most curious things about the management of electrical stations in general is the tendency to look down upon the humble stoker and regard him as a person of minor importance. In most corporate enterprises of a central station character no one short of a person of good antecedents and up-bringing, well known to the company and either vouched for or bonded, is permitted to handle the petty cash. Yet one of the most important expenditures of the company is found entrusted to grimy men in blue overalls who shovel the dollars of the stockholders, in the shape of coal, into the furnaces, and do this day in and day out, practically without accountability.

It is very strange that it has not sooner

been realized that the stoker is a disbursing officer of high responsibility. The contrast between the sum represented by the coal annually shoveled into the furnaces of a first-class central-station plant and the wages of the men who handle it is almost grotesque. Some day the managements of stations will wake up to the fact that one of the largest leaks that can exist in their whole system, whether physical or financial, may be found in the boiler room, and that the remedy for it is the employment only of skilled and trustworthy firemen.

The art of firing a boiler is by no means as simple as it looks to be, and the stoker who handles a shovel and slice-bar with the greatest skill is able to save very many times the difference between his wages and those of the amateur or beginner who is allowed to waste his employer's money in blown-off steam, smoke or clinkers. What is needed in a great number of places is a school for the instruction of firemen. Any one who has ever witnessed the test of a large steam plant, where competent men are employed to feed the boilers, should be fully convinced of the vast importance, from a financial and operative point of view, of skill in the matter of pitching coal into the furnace mouth.

The force of this statement is very much more evident in those districts in which coal is expensive. Along our Atlantic seaboard, where we are blessed with cheap and abundant fuel, a little waste here and there is not a matter of such great importance as it is in those places where coal is expensisve, but waste is waste wherever found, and even with the cheapest fuel the possibility of saving is great enough to indicate the highest economy. No manager can be too careful in the selection of his firemen or in the adoption of methods of payment which will stimulate the men to use their best efforts in the direction of economy. The difference between good firing and bad firing, or between economy and extravagance in the use of coal, may often be enough to determine a profit or a loss on the enterprise.

We have long had trolley mail cars, express cars and freight cars. Now comes news of the trolley sleeping car—between Detroit and Cleveland—a straw which shows how the wind of progress is blowing. The trolley sleeper will doubtless wake up a few railway managers.

ELECTROCHEMICAL PROGRESS.

Among the very first of the phenomena of the electric current which were discovered was the decomposing action which it exerts upon electrolytic conductors, this having been one of the first observations made by Volta after his invention of the electric battery. Perhaps the first application of the electrolyzing power of the current was made by Sir Humphrey Davy, at about the same time that that illustrious experimenter also discovered the electric arc—nearly a century ago.

Coexistent with the telegraph and the working out of the laws of the electromagnet came the first industrial application of electrochemistry to the art of electroplating, shortly followed by that of electrotyping, both of which have now come to be industries of considerable importance.

For many years, however, the uses of the chemical reactions of the electric current stopped with these developments, and, indeed, did not progress to any great extent until very recent years, when the perfection of the dynamo enabled powerful currents to be generated cheaply and conveniently. The new chapter in the history of electrical progress that is rapidly being unfolded by electrochemical investigators and experimenters is one of great interest, but the majority of electrical engineers, confining their attention solely to the mechanical applications of electricity through its magnetic effects, have largely neglected this important branch of the subject.

It may be well, therefore, to call attention to the present magnitude and increasing importance of electrochemical industries, and to show what developments have been made in this direction and what may be expected. Aluminum was discovered, or rather isolated from its salts, by Wöhler, in 1828, but the metal remained simply a curiosity of the chemical laboratory until an electrolytic method was discovered for its extraction. At that time it was used to a very small degree in the manufacture of scientific apparatus and its price was so high that it could fairly be classed with the precious metals. It is now the cheapest metal in common use, except iron, zinc and low-grade brass.

The annual consumption of bleaching powder and caustic soda runs to enormous figures, since both these substances are important in many of the manufacturing arts, notably those of textiles, paper-making, soap-making and a host of chemical manufactures depending upon the alkali base. The invention of a simple electrolytic method for the decomposition of common salt with the formation of caustic alkali and chlorine gas—the essential constituent of bleaching powder—has resulted in very greatly cheapening both these important materials, and thereby also reducing the cost of the numerous products into whose manufacture they enter. With the last few years a number of interesting chemical products have been made by electrolytic processes, among them being chloroform, iodoform and other products used in surgery, several explosives and a large number of colors, dye stuffs and synthetic chemicals finding various uses in the arts. This branch of the industry has only just begun its development, and from it great and increasing results may be confidently expected.

The electric furnace, which may justly be considered as an adjunct to electrochemical processes, has given us several new substances, among them calcium carbide and carborundum, both of which have become the bases of important industries, and its invention put into the hands of the experimentalist a new and exceedingly powerful instrument. The refining of metals, especially copper, once a slow and costly process, has been greatly facilitated and cheapened by electrolytic methods, and to-day the standard of refined copper is that prepared by electrolysis.

From the foregoing it is easy to see that the chemical applications of electricity are of commanding importance and are second only to its applications for motive power, lighting and communication.

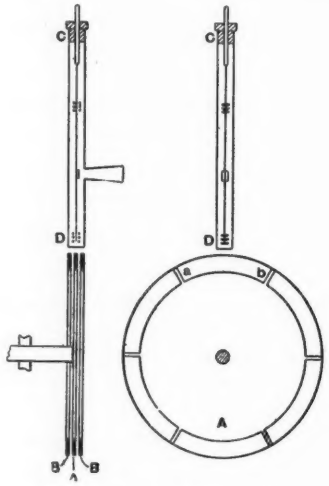
The fine series of papers by Dr. H. C. Jones, concluded in the last number of the ELECTRICAL REVIEW, discussed the principles of electrochemistry in such a way as to give an excellent idea of their applications to industrial problems. The series of articles by Mr. J. B. C. Kershaw will take up the present condition of the industry in the various important countries of the world, and will give a further view of this most important branch of electrical utilization.

Science Brevities

Resistance of Bismuth—One of the many anomalous properties of bismuth is the change which the resistance of a filament undergoes when placed perpendicular to the lines of force in a strong magnetic field. Not only does its resistance very much increase, but, as discovered by Lenard, its resistance to alternating currents under these conditions is apparently different from its direct-current resistance. Lenard thought this difference only became manifest at frequencies of 10,000 per second and upwards, whereas, Sadovsky observed a difference even at a frequency of three or four per second. G. C. Simpson, in an article published in the *Philosophical Magazine,* and digested in Fournier d'Albe's abstracts, attempts to discriminate between the two by means of experiments based upon the following principle: As any small change in the resistance of a wire carrying a current may be considered as the result of an electromotive force set up in the wire, whatever the changes in the bismuth may be due to, they can be regarded as arising from an electro-motive force set up in the bismuth itself. If on examination this electro-motive force (called in this paper the "bismuth electro-motive force") should prove to be opposite in phase to, and of the same wave-form as, the—say, simple harmonic—current causing it, it may safely be inferred that the change in the bismuth is really a change in the resistance pure and simple. But if the "bismuth electromotive force," while still possessing the proper wave-form, should be displaced 90 degrees ahead or 90 degrees behind, it would be necessary to conclude that in the one case there exists something of the nature of capacity, in the other something of the nature of self-induction in the bismuth. The results of the experiments go to show that the latter alternative holds good for small frequencies, and that the rise of resistance is only apparent.

Aluminum Conductors—An installation for the transmission of electrical energy has just been completed near Naples, in the Valley of Pompeii, in which all the conductors used are of aluminum, says the *Electrical Engineer.* This installation consists of three horizontal turbines of 150 horse-power working at 190 revolutions per minute. Each turbine drives a three-phase alternator, and the current at a tension of 3,600 volts is led along three aluminum lines to Pompeii, Sarno and Torre Annunziata. The first of these lines has a length of about two miles, and leads to a substation of two three-phase transformers. The second line, leading to Sarno, has a length of about 10 miles; it conducts the current to a three-phase motor working at 3,500 volts and driving a continuous-current dynamo of 36 kilowatts capacity. This installation supplies a three-wire system at 240 volts. The third line, to Torre Annunziata, is just over two miles long, the current serving for motive power in the neighboring macaroni factories.

Rowland Convection Experiment — In view of Crémieu's denial of the existence of magnetic effect of electric convection, A. Eichenwald has repeated the experiment of Rowland, who first furnished some evidence of a positive nature. His



EICHENWALD'S APPARATUS.

results have been published in the *Physikalische Zeitschrift,* and abstracted in a London journal. Between two vertical zinc plates, BB, a light disk of micanite, A, rotates on a horizontal axis. It is 25 centimetres in diameter, and is covered along both edges with strips of tinfoil, *ab*. The strips of tinfoil form a condenser with the zinc plates, and may be charged by means of sliding contacts. At the upper edge of the plate a vertical tube, CD, of electrolytic copper is mounted, containing a very light astatic pair of needles suspended by a quartz fibre. Every precaution is taken to protect the needles from magnetic influences. Rotation of the uncharged disk produces a deflection which is independent of the direction of rotation. When the disk is charged, another and a larger deflection is superadded, corresponding in direction and amount to that which would be produced by an electric current conveying the same quantity of electricity. The author, therefore, regards Crémieu's negative result as due to disturbing influences.

Magnetic Properties of Human Blood—An article upon this subject has been communicated to the Royal Society by A. Gamgee. Faraday found, much to his surprise, that blood, although containing a large proportion of iron, was diamagnetic, and was led to state that "if a man could be suspended with sufficient delicacy, after the manner of Dufay, and placed in the magnetic field, he would point equatorially; for all the substances of which he is formed, including the blood, possess this property." Plücker showed further that the blood corpuscles are more strongly diamagnetic than the liquid in which they float. A. Gamgee has now proceeded a step further and examined the magnetic properties of the crystalline blood-coloring matter itself, in the condition of utmost available purity. He comes to the conclusion that the blood-coloring matter, oxy-hæmoglobin, as well as carbonic-oxide hæmoglobin and methæmoglobin, are decidedly diamagnetic bodies. The iron-containing derivatives, hæmatin and acethæmin, are, however, powerfully magnetic bodies. The differences in magnetic behavior between the blood-coloring matter and acethæmin and hæmatin point to the profound transformation which occurs in the hæmoglobin molecule when it is decomposed in the presence of oxygen. The preliminary study of the electrolysis of oxy-hæmoglobin and CO-hæmoglobin renders it probable that, in the blood-coloring matter, the iron-containing-group, on which its physiological properties depend, is (or is contained in) an electronegative radical; according to analogy, the iron in such a compound would possess diamagnetic and not paramagnetic properties.

Coherers not necessary for Space Telegraphy—It has been shown by E. Ruhmen, in *Physikalische Zeitschrift,* August 24, 1901, that no coherers are absolutely necessary for space telegraphy, an ordinary telephone answering the purpose well enough for considerable distances. He used a Righi oscillator, with induction coil and turbine interrupter. One ball of the oscillator was earthed, while the other was attached to a mast wire 25 metres long. The receiver consisted of a mast wire five metres long, earthed through an ordinary postal telephone. The distance was two kilometres. Morse signals were easily read. It was found that the telephone answered only to the first of the damped oscillations proceeding from the oscillator. It is,

therefore, desirable to increase the capacity of the oscillator as far as possible. It was found advantageous to insert a condenser in parallel with the oscillator. As regards the receiver, it was found best to put a condenser in the receiving circuit, and read off the signals by means of a transformer. Such was the loudness obtained that it seems quite feasible to convey signals in this manner over 20 miles or so. This would mean a great simplification and extension of space telegraphy. Automatic records could be made by telephone relay or by the Polák-Virag system, and syntonism could be obtained by using Mercadier mono-telephones.

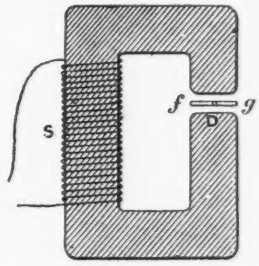
Calcium Carbide in Metallurgy—A long paper on this subject by Von Klügelgen appears in the *Zeitschrift für Elektrochemie* and is abstracted in a British journal. He uses clay crucibles and a commercial product containing 88 per cent of real carbide, $CaCo_2$. The chief reduction is due to the calcium, as shown by the fact that finely divided carbon is left behind when the reaction is incomplete, and actually hinders the union of the reduced globules of metal. The reaction between lead oxide and calcium carbide begins at a dark red heat, and yields carbon dioxide or monoxide, according to the proportions of material. With lead oxide the reaction will not continue without extraneous heat, with chloride of lead it is explosive. Suitable mixtures of the two, with a core of chloride and carbide to act as a primer, do not require extra heat after the start, and yield up to 92 per cent of lead containing very little calcium. Copper oxide is more energetic, the chloride explodes and the metal is not easily obtained in a fused ingot. The process is more or less unsuccessful with zinc, brass and many other alloys, with tin, molybdenum, tungsten, chromium, iron and nickel; bismuth was tractable; aluminum oxide and chloride gave trouble. To prevent oxidation the experiments were conducted under a layer of fused sodium or calcium chloride, which, however, attacked the crucibles. At low temperatures the metal is nearly free from carbon. Calcium carbide may be of valuable assistance to the chemist and assayer, and in refining, but its direct metallurgical value has not been established.

Influence of Oscillations on Electrolysis—Mr. Morris contributes to the *Electrochemist and Metallurgist*, which is abstracted in *Lightning*, a brief article on the work of Broca and Turchini, who have discovered that a disruptive discharge with electric waves of from 350 millimetres to 400 millimetres in length—*i. e.*, with oscillations at the rate of about a million per second—has very different effects on an electrolyte in the circuit from those produced by an ordinary galvanic current. Under certain conditions, when the electrolyte is a relatively very good conductor, disruptive sparks of great power are produced in the electrolyte itself. This shows that to oscillations, at least of the particular frequency above mentioned, the electrolyte behaves almost as a dielectric. This is undoubtedly the cause of transparency of electrolytes to light, a transparency which it was impossible to explain by means of the ordinary electromagnetic theory of light.

Disruptive Discharge in Electrolytes—Broca and Turchini found some time ago that a disruptive discharge may take place in an electrolyte in very much the same way as it does in a dielectric. This, as K. R. Johnson points out in the *Comptes Rendus*, is the conclusion that he had arrived at independently, says a London contemporary. His experiments were made with Wollaston electrodes, which enabled him to make the spark issue from one electrode independently of the other, the explosive distance being furnished by the gas disengaged round the platinum point, and the spark passing between that point and the liquid. To produce the discharges, the author employed an induction coil, a Tesla transformer, and finally a Blondlot resonator. In the last case the discharge was entirely suppressed. In employing an induction coil the author observed that the disengagement of hydrogen and oxygen is solely due to the current at break, the current at make not exercising any electrolytic action. This may, in fact, be easily demonstrated by making and breaking the circuit by hand. It is evident that the electrolytic effects arise from the oscillations which accompany the induced current, and not from an alternative action of the two induced currents.

Electrical Recovery of Tin from Waste Tin-Plate—A new method of economically recovering tin from waste tin-plate electrically is described in *Cosmos*, and abstracted in *Lightning*. A convenient vessel is divided by a porous or permeable partition, preferably, for cheapness, made of wicker-work; one side is filled with coal, the other with waste tin-plate, the former being the cathode, the latter the anode, and the charging liquid being seawater or salt solution. A number of such cells are made and connected up, forming a battery capable of working a separate electrolytic bath. The iron dissolves to ferric chloride, the tin partly falls to the bottom and partly passes to the cathode. The final solution of any remaining iron is effected in the electrolytic bath. This is a kind of closed cycle, in which the separation of the tin and solution of the iron yield the current necessary for completing the cleaning of the recovered metal. No results of actual trials are mentioned. An English patent with the same object (No. 21,533, Matthews & Davies, November, 1900) has cathodes fitting into cells or holders provided with a well at the base to catch the stripped tin. A revolving drum with arms promotes the circulation and detaching of the metal.

Rectifier Based on the Hall Effect—A somewhat sensational application of the Hall effect is proposed by T. des



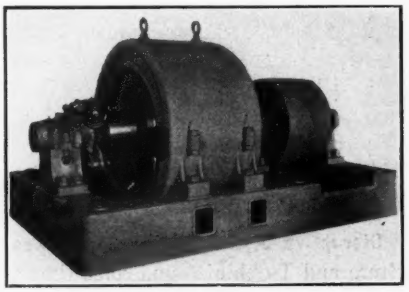
RECTIFIER.

Coudres in the *Physikalische Zeitschrift*, which is abstracted in the London *Electrician*. He points out that if an alternating current is sent through an electromagnet and at the same time through a Hall plate, the lateral electrodes will convey a constant current, since the reversal of the main current is compensated by a simultaneous reversal of the magnetizing current. A simple rectifier based on this fact is shown in the diagram, where a bismuth plate, *f g*, is placed in the air-gap, D, of an electromagnet excited by an alternate current. Lest any rash electrician should plan the commercial application of this elegant device, the author shows by figures that a practical utilization is not to be thought of, as the efficiency would necessarily be very low. But an alternate-current investigation of the Hall effect promises interesting theoretical results, and the new device may profitably be employed not only as an electrodynamometer or wattmeter, but also for the harmonic analysis of current curves with the aid of a sine inductor. The bismuth plate must be very thin for all these applications, but it offers the advantage of a very small inductance.

The Glasgow International Exhibition.

By Sydney F. Walker.

THE Glasgow Exhibition is a very fine one. It is not as large as the Paris Exposition nor as the Pan-American Exposition, now being held at Buffalo, and it has certain limitations which neither of these have or had. Electricity is very much to the fore in the whole place, so much so in fact that it was thought that the winged figure which surmounts the dome was intended to represent electricity It is intended to represent "Light," however. There is a large generating plant for lighting and power purposes, very much larger than is required for the service, and the whole of the buildings, including the very fine art gallery, and a portion of the grounds are lighted by either arc or incandescent electric light. The buildings comprise a fine central industrial hall and a large machinery hall, these two being connected by the Grand avenue, which is also devoted to stalls, and in addition there are a number of pavilions in the grounds, some devoted to the exhibits of particular countries and some to those of particular firms. The Westinghouse company, the English offshoot of the American company of that name, has a very handsome erection, and the British Schuckert Company another, while some exhibitors of American machine tools have also pavilions in Machinery street, as the avenue by the side of the River Kelvin, where these pavilions are located, is called.



Bruce Peebles Motor, Glasgow.

The exhibition itself is placed in a portion of the Kelvingrove Park, the River Kelvin running through the grounds, in which several waterfalls and other attractions have been improvised, while the handsome university buildings and those of the infirmary which overlook the exhibition grounds, add very much to the effect. The British Schuckert Company has a searchlight mounted on a tower on the university side of the grounds, from which it causes the beam to play over the grounds and the adjacent buildings, to the intense delight of visitors, of whom there have been over 100,000 in one day.

Though the exhibition is run by a separate committee, got up in the usual manner, the whole arrangement is dominated very largely by the corporation of Glasgow, who has assisted very materially with the undertaking, and who has the entire lighting of the grounds and the buildings in the grounds in its hands, as well as the lighting of the main buildings, the industrial and machinery halls and the Grand avenue, after the generating station shuts down at 9 P. M. This is a very wise arrangement, and the whole is very well carried out, the corporation supply service being arranged to come into operation instantly in case of mishap at the generating station, and the corporation officials having taken special precautions, by duplicating feeding points, cross-connecting, etc., to minimize the chances of a breakdown of their service. But it leads to one or two curious results, some of which may give the electrical men a lesson. The corporation, for instance, is owner

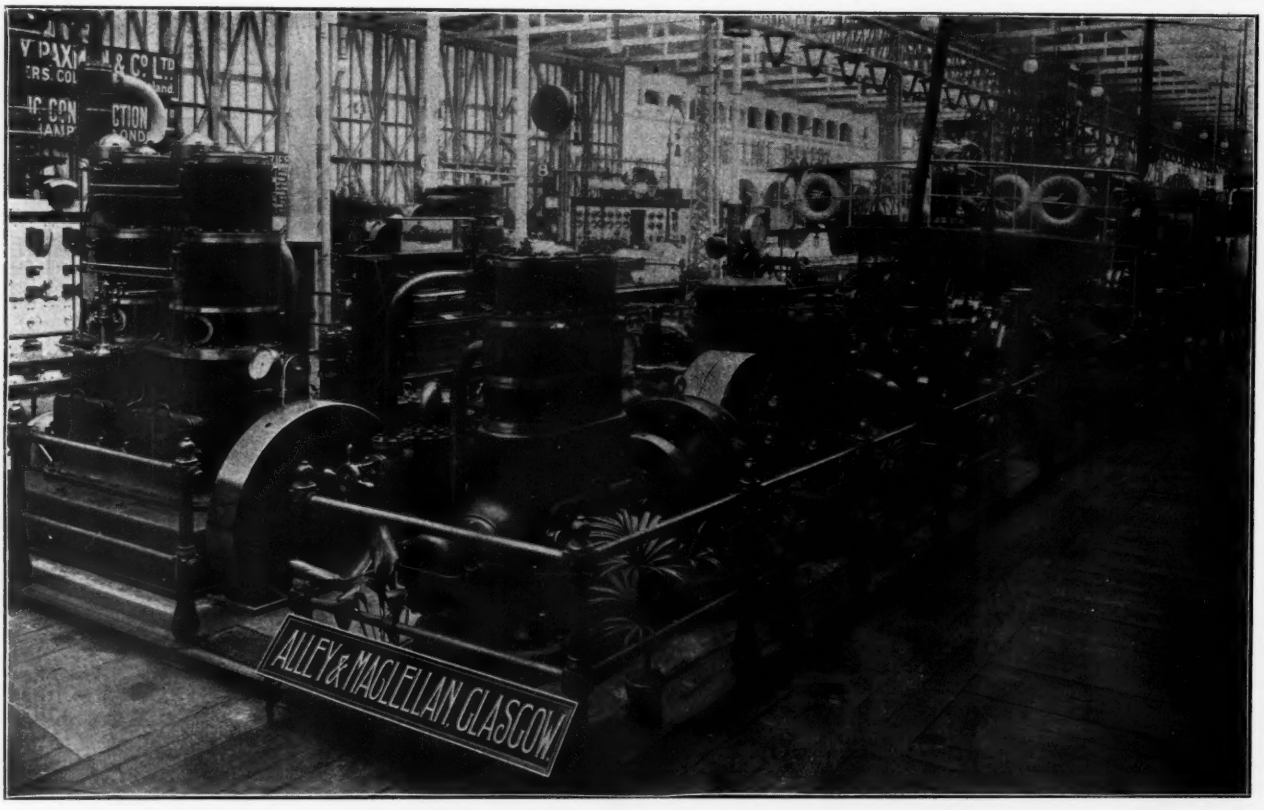
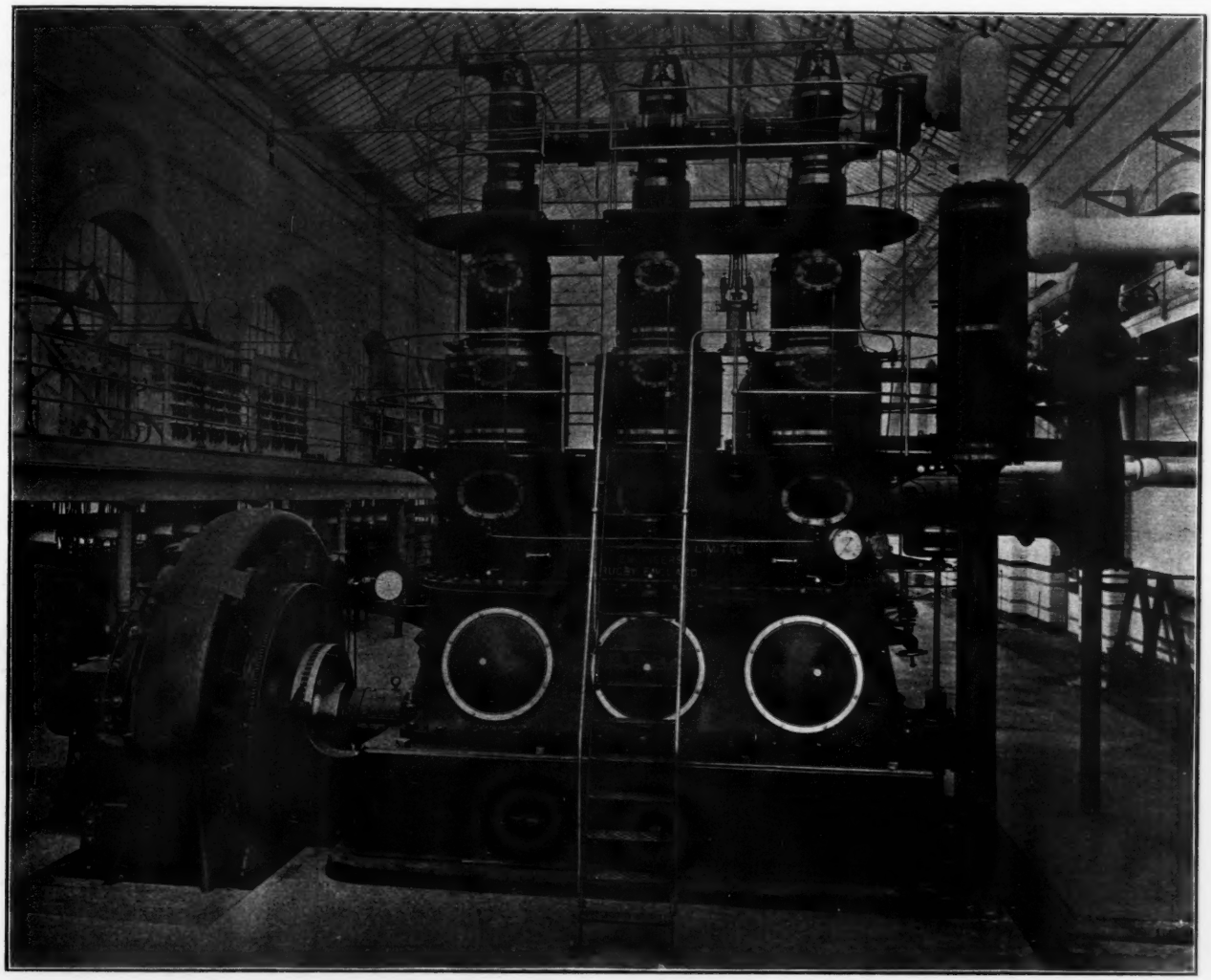


Exhibit of Messrs. Alley & Maclellan at the Glasgow Exhibition.

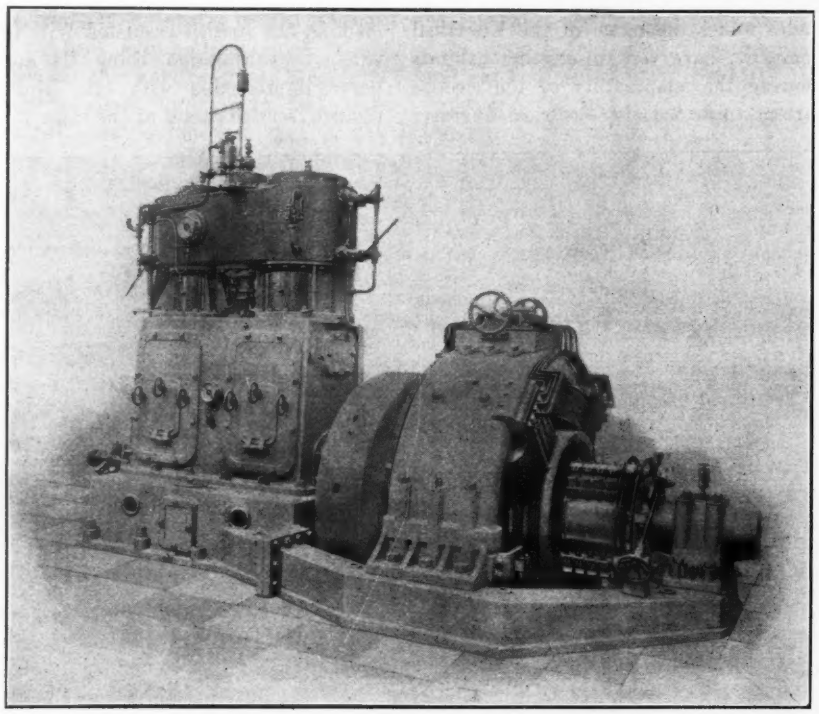
of the gasworks as well as of the electric lighting works and the electric tramway service, and it has lighted a large portion of the grounds with high-pressure gas, and has done it remarkably well, too. It is not too much to say that, while the gas illumination does not present that pretty moonlight effect that we are so used to, and like so much, with arc lamps, the lighting by gas is at least as good as that by electricity, and that is saying a good deal in this case. As usual, the gas men claim a "knockout" for the gas as against the electric light. It is not this by any means, but it will or should give those electrical men who are suffering from "swelled heads" something to think over.

The dominance of the corporation leads also to the result that alternate-current apparatus, notwithstanding the hold that it has obtained in the country, and is likely to obtain, has to take a very back seat. There is only one alternator generator shown, as a generator pure and simple, and that of only 240 kilowatts, and by a new firm, the Lancashire Dynamo Company, though it furnishes three-phase currents at 5,000 volts, which are ingeniously dealt with about the company's stall. The British Schuckert Company, the Westinghouse company and the German company which trades under the name of the Electrical Company, have very interesting exhibits showing the adaptability of the electric current, provided the electrical engineer has the apparatus; but it is subsidiary to the all-ruling continuous current at 500 volts. That is the pressure of the corporation service, the lighting service being run at 250 volts, on the three-wire system, with balancers in the usual way, and all motors of over 10 horse-power being connected to the outers, but it necessitates that everything in the exhibition shall fall in with this 500-volt service. The generating station is on the three-wire system, some of the generators furnishing current at 500 volts and some at 250 volts, the whole being brought to a main switchboard arranged for the three-wire system, with a balancer able to deal with 100 amperes out of balance, and its balancer switchboard. For the power service in the machinery hall a double-ring main is fixed running right around the building, consisting of a triple concentric cable made by the British Insulated Wire Company, the insulation being its special paper impregnated with oil. For the lighting service cables of the same manufacture are led to switchboards in different portions of the main buildings, while the current is divided up for the arc lighting and such incandescent lighting as may be required inside the buildings, 10 arcs being connected in series from one switch, across the outers. At these switchboards also there is a throw-over switch enabling the corporation supply to be switched on instantly if required. The arc lamps, of which there are over 1,000 in use about the buildings and grounds, are the Brockie-Pell, taking from 9 to 10 amperes and about 45 volts each. The power required



WILLANS ENGINE DIRECT-COUPLED TO SCHUCKERT DYNAMO, GLASGOW EXHIBITION.

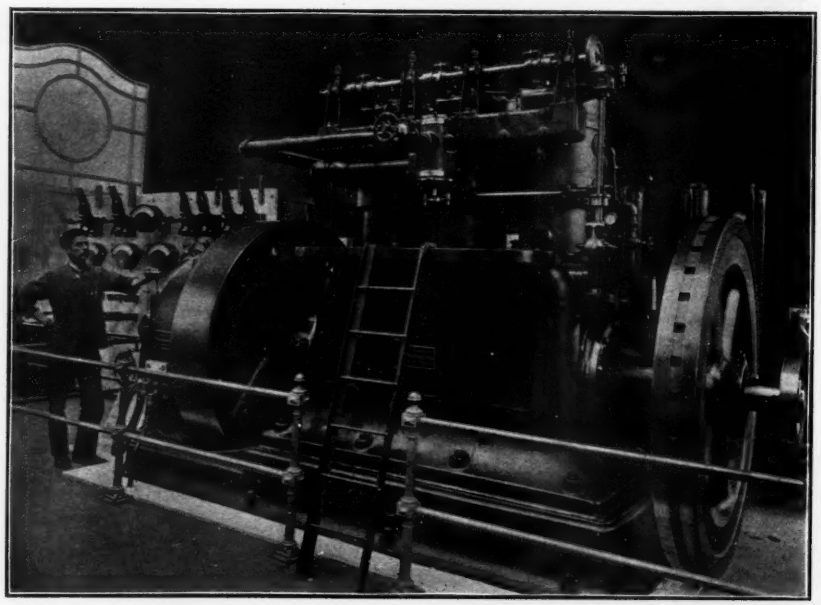
by exhibitors for running their machines may be had in four different forms. Steam pipes are carried all down the machinery hall; there are two lines of shafting, one on each side of the hall, one line driven by a stationary engine and the other line driven by a 150-horse-power electric motor supplied by and working at Messrs. Bruce, Peebles & Company's stall, this in addition to the supply of current direct from the ring mains.



Ernest Scott & Mountain Engine and Dynamo, Glasgow.

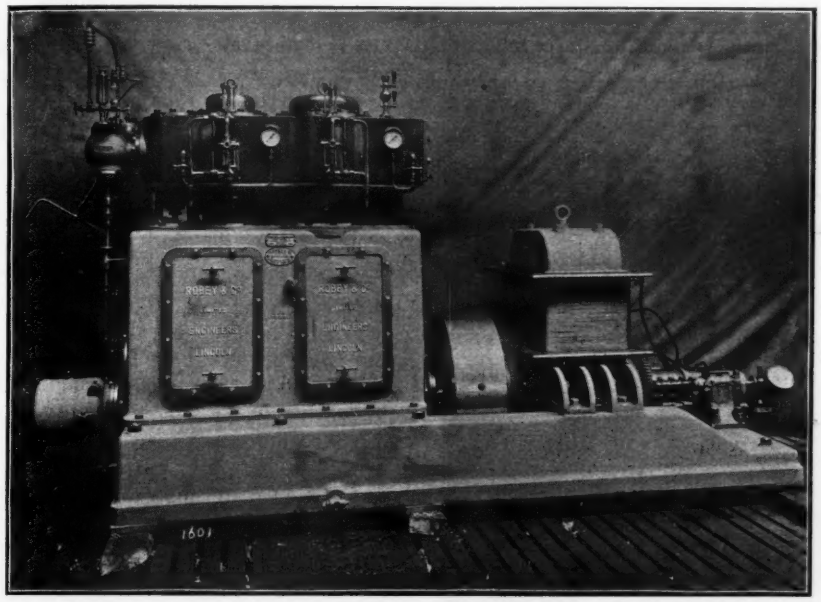
In the interesting exhibits mentioned above, the 500-volt current is taken and converted by means of a motor-generator to an alternating current of some form, usually three-phase, in which form it is passed through a static transformer, raising its pressure to different voltages up to 10,000 volts, from which it is again transformed down, and is again converted to continuous current, from which again the changes are rung, there being on the same stall and from the same supply often apparatus taking continuous current or generating continuous current at as low as four volts, and different other apparatus taking or generating currents of various forms and various pressures up to 10,000 volts. In the case of the Westinghouse company, it generates current by means of its own gas engine, which has two cylinders taking gas in succession to each other, but the transformations from the generator driven by the gas engine are much the same as with the others. The British Schuckert Company also uses a motor-generator to reduce the 500-volt service to 110 volts for its searchlight.

The generating plant for the exhibition lighting and power service consists of four plain Lancashire boilers, made by Messrs. Penman, of Glasgow, and fitted with rocking furnace bars; two of Babcock & Wilcox land water-tube boilers, with their chain mechanical stokers; two Stirling water-tube boilers, one fired with coal and the other by means of gaseous fuel; two of Davey-Paxman economic boilers and one of Babcock & Wilcox marine type of water-tube boiler. There are feed-water heaters, economizers, etc. The engines and dynamos consist of two of Willans triple-crank, triple-expansion engines, each crank having its own tandem triple engine above it. One of the sets is coupled to a British Schuckert dynamo, furnishing 550 volts and 1,320 amperes, and the other to a Crompton dynamo of similar capacity. One Robey cross-compound, horizontal engine, carrying the armature of a Mavor & Coulson dynamo as part of its flywheel, running at 90 revolutions per minute and furnishing 550 volts, 700 amperes. One Davey-Paxman horizontal, cross-compound engine, carrying an Electric Construction Company's armature as part of its flywheel and furnishing 550 volts, 550 amperes, when running at 150 revolutions per minute. One Bellis triple-expansion, vertical engine, coupled to a Bruce-Pebbles dynamo, furnishing 550 volts, 380 amperes, when running at 400 revolutions per minute. One set of engine and dynamo, directly coupled, all made by Messrs. Ernest Scott & Mountain, of Newcastle-on-Tyne, the enclosed type, furnishing 250 volts, 565 amperes, at 360 revolutions per minute. One Alley & Molellan triple-expansion engine, enclosed type, vertical, directly coupled to a Mavor & Coulson dynamo, furnishing 265 volts, 680 amperes, at 380 revolutions per minute. One Browett-Lindley vertical engine, compound, of the enclosed type, directly coupled to an Ediswan dynamo, furnishing 250 volts, 520 amperes, at 380 revolutions per minute. One



Westinghouse Gas Engine at the Glasgow Exhibition.

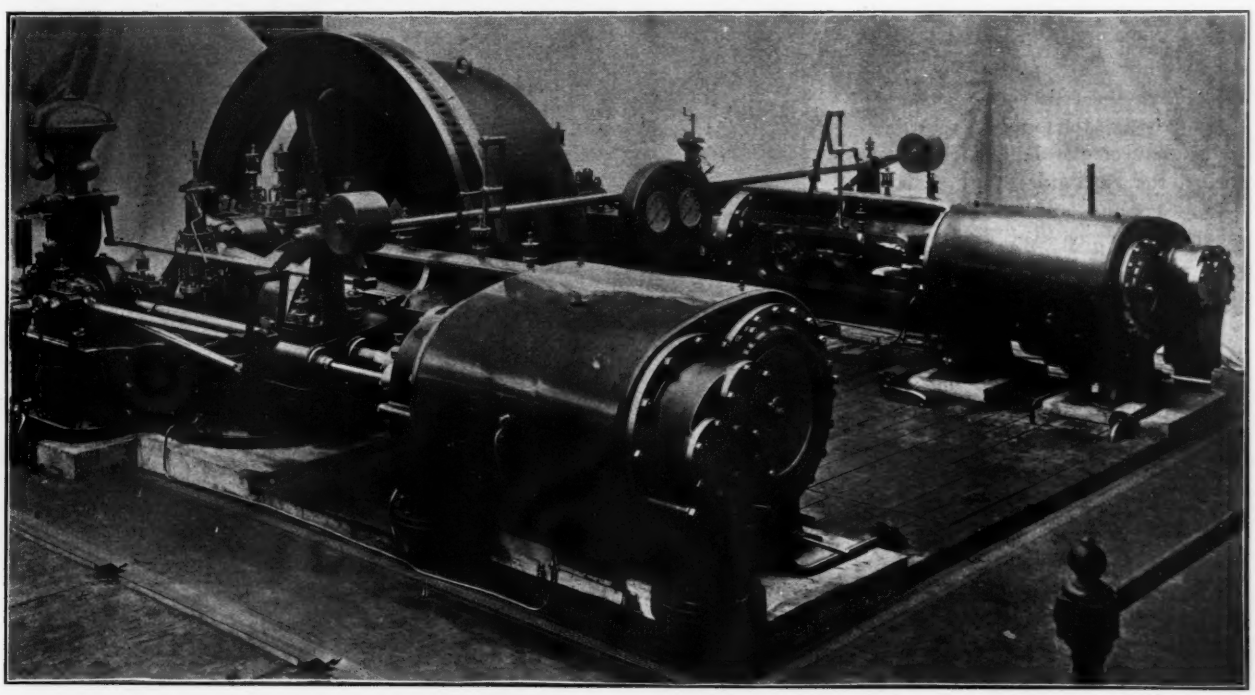
Sisson engine, compound, vertical, enclosed type, directly coupled to a Clarke-Chapman two-pole dynamo, furnishing 250 volts, 400 amperes, at 400 revolutions per minute. The Sisson engine has the special feature that the two cylinders are partly arranged tandem and partly side by side, as shown, this arrangement being claimed to give increased steadiness. One Robey vertical engine, vertical enclosed type, coupled to an Ernest Scott dynamo, furnishing 250 volts, 200 amperes, at 250 revolutions per minute. One Robey engine, compound, vertical, open type, coupled to a two-pole Ernest Scott dynamo, furnishing 250 volts, 200 amperes, at 550 revolutions per minute. One Ruston-Proctor compound engine, vertical, enclosed type, coupled to a "C. & C." dynamo, furnishing 260 volts, 320 amperes, at 450 revolutions.



ROBEY ENCLOSED ENGINE AND SCOTT DYNAMO.

The motor balancer is by Messrs. Bruce-Peebles, and is capable of dealing with 250 volts, each branch, and 100 amperes, at 1,000 revolutions per minute. It will be seen that the various types and speeds of engines and dynamos are very well represented, with the exception of the alternator. Also that, so far as the exhibition plant is concerned, belt or rope driving has completely disappeared, except in the case of the belt used to drive the shafting from the motor in the machinery hall, and this pretty well expresses the prevailing idea in England at the present time. With direct driving less space is taken up, often an important matter in a town supply station, while one possible cause of failure, and a very serious one, is eliminated.

In addition to the above, the General Electric Company, of England, the German firm which is now completely Anglicized, has a dynamo running at one of its stalls, coupled to a Peache three-crank, vertical compound engine, each crank having its own set of engines, the whole being coupled to a six-pole compound, continuous-current generator, furnishing 500 volts and 420 amperes, when running at 350 revolutions per minute. The engine is by Messrs. Davey-Paxman, on the Peache patents. The current from this set is used to supply a number of motors throughout the machinery hall, principally those for driving the sweetmeat machinery at three large stalls, where the public can see the whole process by which the toothsome stuff is produced.



DAVEY-PAXMAN CROSS-COMPOUND ENGINE WITH ELECTRIC CONSTRUCTION COMPANY'S DYNAMO, GLASGOW.

Messrs. Mavor & Coulson and the British Schuckert Company also supply current to a number of motors of various sizes, distributed through the Grand avenue and the industrial hall, such as weav-

ing looms, refrigerating apparatus, etc. This arrangement enables the objectionable features of steam and shafting to be kept out of those departments, and at the same time enables the different machines, in which the general public are always interested, to be shown at work.

INTERIOR OF WESTINGHOUSE PAVILION, GLASGOW EXHIBITION.

FOREIGN FIRMS MORE TO THE FORE THAN BRITISH FIRMS.

This is one of the noticeable features of the exhibition, at any rate so far as the electrical portion is concerned. By far the largest and best of the purely electrical exhibits is that of the British Schuckert Company, the apparatus of which is all made in Germany, and the bulk of the attendants of which can hardly speak English. And the British Westinghouse Company, and the German company calling itself the Electrical Company, come very close behind the Schuckert Company, though it should be noted that the exhibit of Messrs. Mather & Platt, of Manchester, bulks very largely, has many very important novelties and is certainly one of the best in the exhibition.

MESSRS. MATHER & PLATT.

But Messrs. Mather & Platt's show is very largely taken up with other apparatus than electrical, and some of the most interesting portions of their electrical exhibits are only incidentally electrical, while nearly all the most interesting parts of their stall are not connected with electricity, even remotely, such as their sewage plant, their bleaching plant, their fire-extinguishing plant and their filters. On the other hand they have some very interesting apparatus, even from the electrical engineer's point of view, such as their centrifugal high-lift pumps, lifting water to a height of 400 feet, and directly driven by electric motors running at 1,000 revolutions per minute and upward; their electrically driven three-throw mine pump with variable stroke, the pump and the motor driving it always running at one speed; the overhead traveling electrical railway, shown running over the stall, intended for carrying parcels about a station, and actually in use at the Victoria station of the Lancashire & Yorkshire railway. The dynamo they exhibit, though it is not running, is the largest in the exhibition, and is a fine example of English work, the massive type, as against the lighter types so often found in American and Continental types. They also show samples of their dynamos, engines, enclosed motors, etc., electrical drilling and other machines.

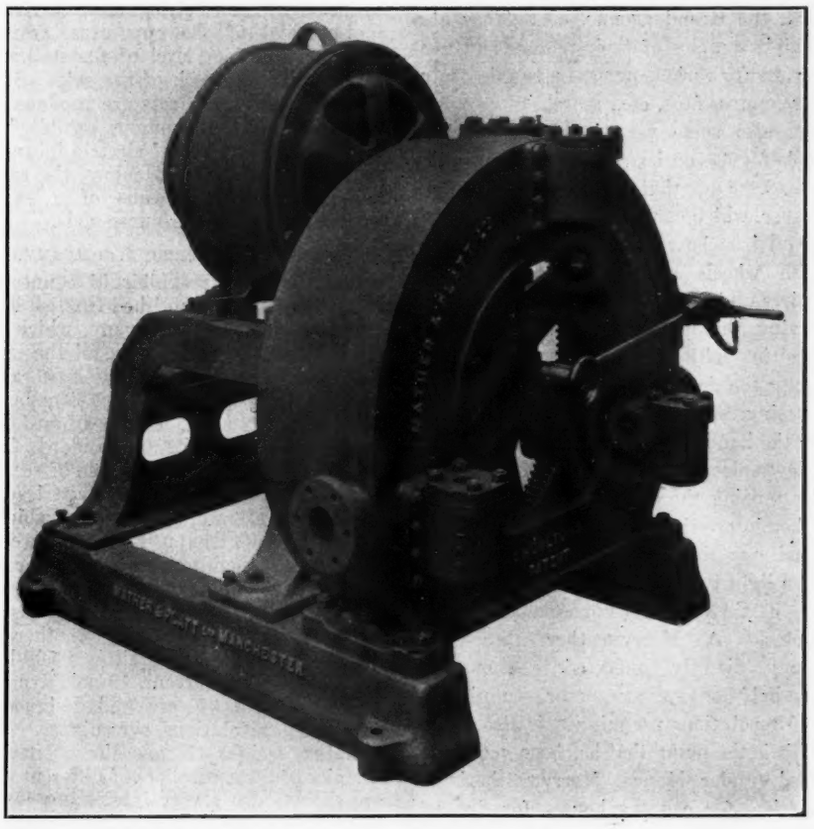
ANOTHER VIEW IN THE WESTINGHOUSE EXHIBIT AT GLASGOW.

THE BRITISH SCHUCKERT COMPANY.

As already mentioned, this firm has two distinct exhibits, one at its stall in the machinery hall and the other at its pavilion in Machinery street in the grounds. At its stall it has a fine show of its apparatus of all kinds—motors, generators, transformers, arc lamps, with various patterns of posts and different methods of connecting the lamp with the mains without bringing the leads down to the ground when the lamp is lowered for cleaning and renewal of the carbons; electricity meters of various forms, and for all supply services, switches of all kinds, with the usual marble switchboard, and other things. Two features the visitor will find of interest at the Schuckert Company's stall, the historical collection, comprising the first dynamos made by the late Herr Schuckert, the early arc lamps, the first Pilsener lamp, etc. The other matter is the special form of synchronizer, consisting of a number of incandescent lamps arranged in circles on a disc, the disc being carried at the top of a pole high enough to be seen all over a comparatively large central station. When certain of the lamps are alight, the incoming machine is in synchronism. The disc which carries the lamps also carries

the synchronizing transformers, on its other side.

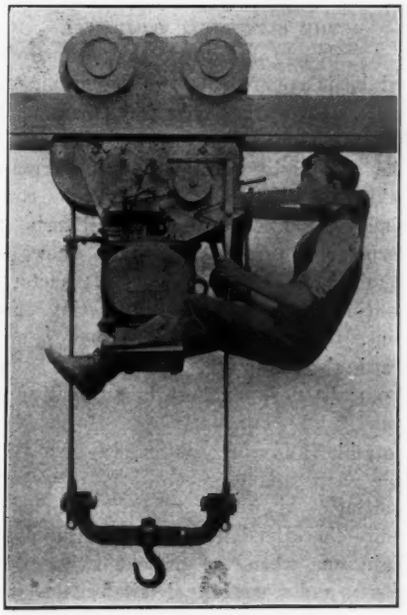
At its pavilion on the grounds and on the piece of ground adjoining it shows small electric locomotives, designed for mining work, one worked by a battery of 39 accumulator cells, equal to a discharge of 63 ampere-hours, at the one-hour rate. The other locomotive is fitted with a special form of trolley, consisting of an aluminum roller, which is pressed up against the trolley wire by springs, as the locomotive runs along the track. The accumulator locomotive is stated to have been working at a mine in Germany for two years, and did not look much the worse as accumulators go. Inside the pavilion it shows a very fine set of pumps made by Erhardt & Sehmer, of Saarbrucken, driven by a 12-pole, continuous-current motor, able to convert 970 amperes at 500 volts, when running at 146 revolutions per minute. There is also a very pretty little mining haulage plant for main and tail work, as it is termed in this country, with controller arranged to be worked by the ordinary engine-man's lever, automatic brake, mechanical and electrical, and a special form of clutch which allows the shaft to slip in case a dangerously heavy load is put upon it. Another very pretty apparatus which is shown in the Schuckert Company's pavilion, which is interesting both to electrical engineers and to outsiders, is its apparatus for blowing out the spark on breaking the circuit of a 10,000-volt service. The 10,000-volt, three-phase currents are produced by conversion from the 500-volt, continuous corporation supply service by means of a motor-generator, the three-phase current produced being passed through a static transformer, to raise it to the 10,000. From the static transformer the current is allowed to pass into a tank of water to the extent of 100 horse-power, and the circuit is broken on this; the circuit-breaker has two sets of copper connections arranged in parallel, in the usual manner, the actual break occurring between the pair which carry very little of the current when it is passing through the switch, and the repelling action of the current itself, aided by an iron screen, causing the spark to pass upward very much like some pretty cloud effect, such as one sees occasionally in the tropics, and to blow itself out. It also shows some useful forms of drilling machines, with electric motors attached, the motors being mounted on an extension of the arm which carries the drill shaft, also some rock drills for mining work. It should be mentioned that Messrs. Mather & Platt show some drilling machines for workshop use fitted in the same manner as those of the Schuckert Company, and, in addition, they provide with some of their apparatus of this kind a holding-down electromagnet, concealed in the base-plate of the machine.



MATHER & PLATT VARIABLE STROKE ELECTRIC PUMP, GLASGOW.

THE BRITISH WESTINGHOUSE COMPANY.

As will be seen from the drawing, the pavilion occupied by the Westinghouse company is very artistic, more like a Greek temple than a machinery depot. Inside it is a sample of the Westinghouse gas engine furnishing 125 horse-power and driving a 75-kilowatt, 120-volt, continuous-current, six-pole dynamo, to which it is coupled directly, and the current from which is taken to different apparatus in the pavilion, transformed up and down, in and out, as already described, winding up by driving a cross-compound, vertical engine, in which no steam is present, by means of an eight-pole, continuous-current motor, whose armature is arranged to form part of the flywheel of the engine, the engine itself being rated at 500 horse-power, and being capable of working up to 700 horse-power. The motor simply overcomes the friction of the engine in this case, and the installation is a very interesting one. It has also a curious appearance, as if the engine was driving the motor as a generator.



MATHER & PLATT OVERHEAD TROLLEY CARRIER, GLASGOW.

The Westinghouse company also exhibits one of its electrically equipped tramcars fitted with two 35-horse-power motors carried by separate bogies, and connected to the axles by single reduction steel spur gearing. The car is arranged

to seat 70 passengers—30 inside and 40 outside—and the fish-pole trolley has the unusual arrangement that the springs which keep the trolley pressed against the wire are carried inside the pillar which supports the fish-pole. The car is fitted with Milnes electromagnetic slipper brake, which is stated to grip the rails, and in place of forcing the wheels away from the rails, as all other slipper brakes do—all purely mechanical ones, anyway—it pulls the wheels down on to the rails and so adds to the braking power. Sawyer-Man incandescent lamps are shown in the Westinghouse pavilion.

THE ELECTRICAL COMPANY.

As already indicated, this company's exhibit is one of the best in the machinery hall among the electrical firms. It has the same arrangement for showing the adaptability of the electric current, taking the supply service at 500 volts, continuous, and converting it to all sorts of forms and pressures. It also shows a detailed set of samples of its motors, continuous current and alternating current, from one-eighth horse-power upward, also motors fitted to machine tools, from the very smallest breast drill upward, and again in various forms for portable and for stationary purposes. The Nernst lamp, for which we are all waiting, is shown, lamps waiting for current—the attendant had not ventured to light one when the present writer was there—and a carefully detailed case showing the different parts of the lamp, the heating apparatus for ignition, the automatic cut-off when the lamp is lighted, etc. There are cases of beautifully got up samples of cables for all purposes, also samples of switches for all currents and for all pressures up to 15,000 volts, but perhaps the most interesting apparatus on this stall is the electrical steam and steering telegraph. The steam telegraph takes the place of the engine-room telegraph, and is worked by a series of electromagnets arranged in a circle inside the usual box that is carried on the bridge, the electromagnets acting on two specially formed needle magnets to which are attached the pointers which move over the disk. Moving the handle, a similar one to that used with ordinary mechanical telegraph, by means of resistances under the dial, directs more current into one set of electromagnets and less into another, and so draws the needles round and the pointer with them. The steering apparatus is the same, but the helm itself is caused to work another dial by means of a strap, and repeats back to the bridge or the conning tower the actual condition of the helm at any moment, and after the message has been received.

MESSRS. BRUCE-PEEBLES & COMPANY.

This firm, which is a young one, comparatively, located in Scotland, has been mentioned before in connection with the generating station and with the driving of the shafting in the machinery hall. It has a very good show, though not a large one, an electric capstan and an electric haulage plant for mines being the most interesting. In addition it shows samples of its motors for various purposes, its liquid resistance, and other apparatus.

MESSRS. MAVOR & COULSON.

This is another of the largest of the purely British exhibits. In addition to their share of the generating plant they run a Paul compound, vertical engine of 25 horse-power, directly coupled to a four-pole, continuous-current dynamo, running at 300 revolutions per minute and furnishing current for driving some of the machinery at the stalls in the industrial hall, the Grand avenue, etc. They also exhibit samples of their motors and generators for various purposes, running mining pumps, fans, etc., searchlight apparatus, also some very ingenious machine tools for use on board ship and in similar places. One that is novel is the deck planer, which consists of an electric motor in an iron box, carried on a light truck, with wheels and handles and having knives under the motor so that a workman having the power from the ship's own electric light plant can run the truck along the deck, planing as he goes. The starting resistance and switch are carried on the handles of the truck, together with a lever placed close to the workman's hand for putting the current on and off. Another interesting exhibit by this firm is a small portable drilling machine mounted on a light two-wheeled trolley, and worked by a three-quarter-horse-power electric motor. A Merryweather three-throw pump, directly connected to a one and one-half-horse-power motor, running at 300 revolutions per minute, is also shown. This is the pump that has been very much used, under Messrs. Merryweather's initiative, for country houses for fire and other purposes. It is very compact and convenient. Perhaps the most interesting exhibit by this firm is the Hurd's electrical coal-cutting machine, which is of the revolving-bar type, the only one of the type that has survived in this country. It is not shown running, but can be coupled up to any of the circuits at short notice.

MESSRS. CLARKE, STEAVENSON & COMPANY.

The only other coal-cutting machine that is exhibited is a disk longwall machine, exhibited by Messrs. Clarke, Steavenson & Company, of Barnsley, Yorks. It is also driven by an electric motor, and is shown running to any one who is interested in the matter. It is the only exhibit of this firm.

MESSRS. CLARKE, CHAPMAN & COMPANY.

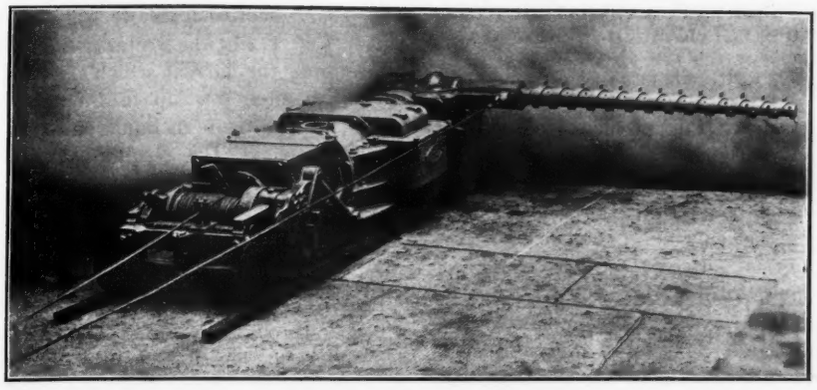
This firm has also a very large exhibit but, like that of Messrs. Mather & Platt, it is not confined to electrical apparatus, though it has a good display in that line. Messrs. Clarke-Chapman's specialty is ship work, and their stall exhibits very forcibly, again, the substantial character of English work, more particularly that used on board ship. They exhibit samples of their engines and dynamos for various purposes, also for continuous currents and for three-phase, always on the same substantial lines, but their most interesting exhibits are their electric windlasses and capstans, and their searchlight apparatus. A model of a conning tower occupies the middle of the stall, forming an office for the attendant, and a platform for the searchlight with which evening visitors are entertained, and which is controlled by means of two electric motors carried in the pedestal of the apparatus, from a pillar on the floor level of the stall, this representing the deck of the ship. Some very pretty water effects are produced in connection with the pumps exhibited by this firm, by the aid of electric incandescent lamps of different colors, the colors being changed by means of a switch worked by one of the pump rods.

MESSRS. DICK, KERR & COMPANY.

This is a joint exhibit in connection with the recently established English Electric Manufacturing Company, which has established new works, with all the latest machinery for electric traction work, at Preston, in Lancashire. The firm makes everything from the car downward and upward. It exhibits a standard four-wheel, single-truck car, capable of seating 56 passengers, and with the stairs leading to the roof reversed, a feature for which it claims several advantages—safety, two additional seats on top and cover for the driver and conductor. Four hundred cars of this pattern are stated to be in use in Liverpool and Portsmouth. Another important exhibit on its stall is a 500-kilowatt, continuous-current, 10-pole dynamo, weighing about 35 tons and designed to run at 90 revolutions per minute. The armature weighs 15 tons alone. Several samples of car controllers of different sizes are shown, also a very interesting assortment of points and crossings, with removable steel pieces to take the wear of the wheels at the points, also several samples of apparatus in connection with light railways, such as a sugar-cane wagon made of angle iron, a tip wagon for light railways, etc.

MESSRS. RICHARDSON, WESTGARTH & COMPANY.

This is a firm representing the amalgamation of two of the oldest and largest engineering firms on the northeast coast of England, and it exhibits samples of



MAVOR & COULSON BAR COAL CUTTING MACHINE, GLASGOW.

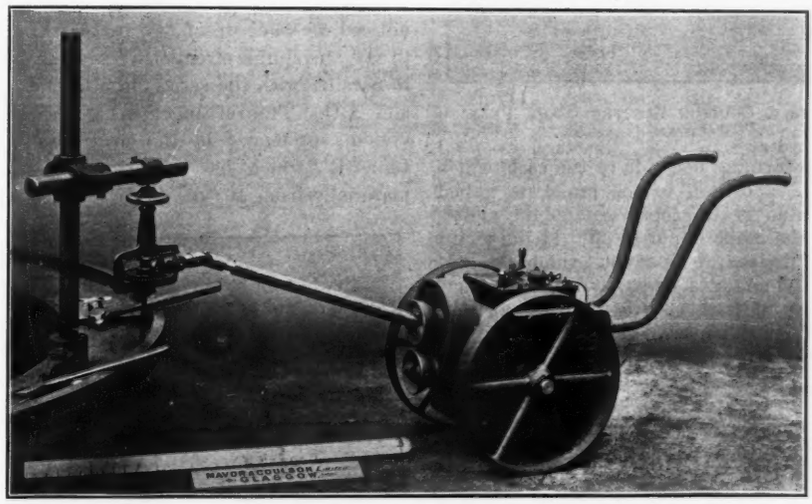
the apparatus made by Messrs. Brown, Boveri & Company, of Baden, Switzerland. It shows a vertical, cross-compound engine of its own manufacture capable of furnishing 600 horse-power, directly coupled to a Brown-Boveri 10-pole, continuous-current generator, the apparatus is designed to furnish 240 volts at 150 revolutions per minute. It also exhibits several samples of Brown's three-phase induction motors, and of his switch-control gear for continuous and alternate currents, with reversing switches.

THE LANCASHIRE DYNAMO COMPANY.

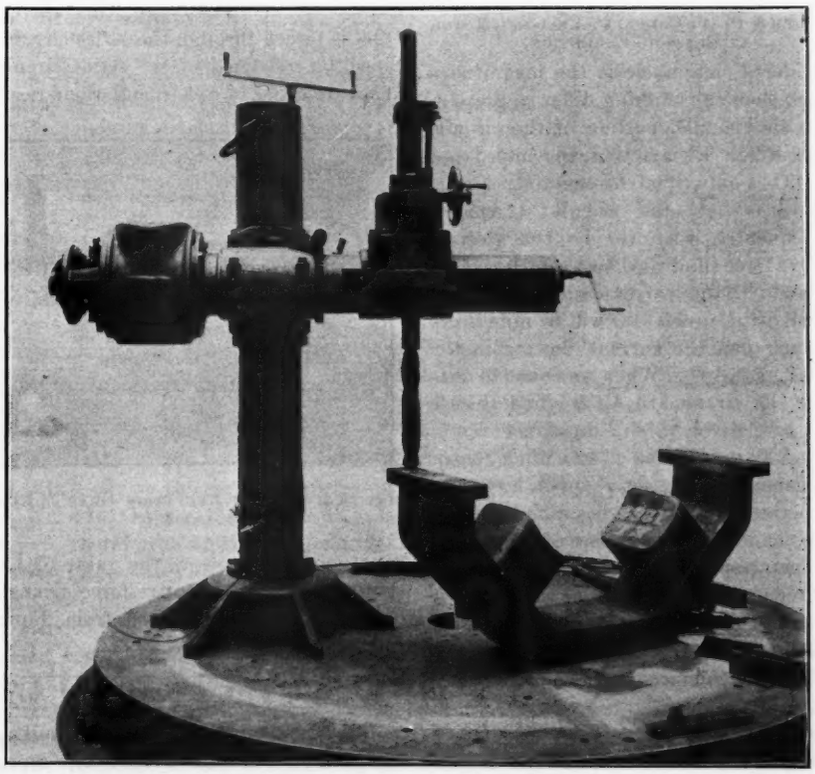
This firm, as already indicated, exhibits the only alternator of any size, and the only one actually generating alternate currents at first hand, in the exhibition. It furnishes a current of 23 amperes per phase, three-phase, at 5,000 volts, when running at 150 revolutions per minute, and is directly connected to a cross-compound, vertical engine made by Messrs. Hick, Hargreaves & Company, of Bolton, Lancashire. The slow-speed engine, as against the quickly revolving engines of which so many are in use in the exhibition, is very well represented in this engine. Messrs. Hick-Hargreaves is one of the best-known firms, makers of Lancashire mill engines. The current from the dynamo is taken to a motor-generator on the stall, running at 600 revolutions per minute, where it is transformed to 500 volts, continuous current, and this current is used about the stall.

OTHER EXHIBITS OF INTEREST.

One of the most interesting is the exhibit of the Glasgow *Herald,* which is printed in the exhibition by means of one of Hoe's latest machines capable of turning out 48,000 papers an hour, printed and folded. The difficulty, as is well known, with printing apparatus is the machine must be arranged to run at any speed, from that required to turn out a few copies per hour to its full output. In this case the arrangement for accomplishing this consists of a 100-horse-power motor which can receive its current directly from the 500-volt supply service or from the auxiliary apparatus which reduces the pressure to 75 volts. The auxiliary apparatus consists of a motor-generator through which the current is passed for the light loads. In addition, resistances are used with both supplies, and automatic apparatus is provided by means of which the current is cut off from the main motor and a brake applied, should it be required by pressing a button on one of a number of pushes distributed over the machine. The whole is worked from one controller, somewhat similar to an accumulator controller with a wheel.



MAVOR & COULSON PORTABLE ELECTRIC DRILL, GLASGOW.

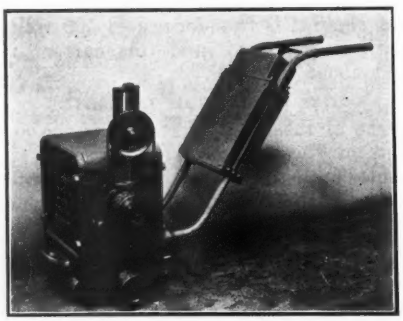


MATHER & PLATT ELECTRIC DRILL, GLASGOW.

A NOVEL BRAKE FOR ELECTRIC HOISTS AND SIMILAR APPARATUS.

This is exhibited by Messrs. Claud Hamilton & Company. The motor is geared to the hoisting drum by worm gearing, and there is a pulley between the motor and the worm. It may form the coupling, if desired. Over this pulley a brake band is suspended, held against the pulley by springs provided for the

purpose. The brake band is attached to an extension of one side of the case of the enclosed motor which is to drive the hoist, the plate forming that side of the case being pivoted in opposition to the springs controlling the brake band. When the motor is not running the brake is on by the pull of the springs. When a current is passing through the motor the



MAVOR & COULSON ELECTRIC DECK PLANING MACHINE, GLASGOW.

plate forming one side of the case, which is in opposition to the brake, is pulled down on to its proper seat on the motor, and the brake is pulled off. If the motor loses its load or its current the brake goes on; the motor is series wound. The same firm exhibits an electric lamp signal indicator for ship's use. Each filament of the sidelight or masthead lamp is in circuit with an electromagnet, whose office is to hold its armature off a back contact. When the filament goes, or the current is cut off from any cause, the armature is released, the back contact is made, the local circuit formed, which may include a bell or a tell-tale lamp.

Messrs. Selby, Bigge & Company exhibit, among other things, a working model of a punching, shearing and side notching machine in one, run by an electric motor.

Messrs. Kelvin and James White supply the main switchboard, which is a very substantial piece of apparatus, consisting of 21 double marble panels, with the usual instruments for distributing on the three-wire system.

The Electric Power Storage Company exhibits one of the two motor cars in the exhibition. It is a Victoria and carries 40 E. P. S. motoring cells, with a two and one-half-horse-power motor, the batteries being concealed under the seats. The weight is stated to be 2,200 pounds for a 25-mile run without recharge, and 2,350 pounds for a 35-mile run.

The General Electric Company, of England, has a very varied assortment of apparatus ranging from electric bells up to apparatus for traction purposes.

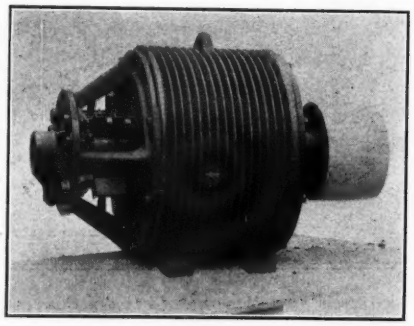
The Consolidated Telephone Company and the Ericsson Bell Telephone Company both have extensive exhibits of telephone apparatus, the latter having several novelties.

There are also many electrical apparatus of different kinds distributed through the machinery and other halls, and there is an electric launch plying for hire on the Kelvin River, where it runs through the grounds.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XLV.

BY W. ELWELL GOLDSBOROUGH.

In solving this problem, the method already outlined on pages 36, 63 and 91 will be employed, as it affords the most direct method. Initially, then, we must assume that only one of the two alternator circuits is active. We will, therefore, assume electro-motive force E^{III} to be eliminated for the present, and the electro-motive force E^{I} to be impressed upon a system consisting of the series circuits OA_4 and A_4A_1, connected in series with the parallel circuits O′O and $O'A_3A_6O$. The parallel part of the system, it will be noticed, is made up of two parts; that is to say, the simple circuit O′O is connected in parallel with the series circuits $O'A_3A_6$ and A_6O. This arrangement gives us a system, influenced by the electro-motive force E^{I}, which has properties differing materially from any of the circuits so far



MATHER & PLATT COMPANY'S ENCLOSED MOTOR AT GLASGOW EXHIBITION.

considered, inasmuch as the magnitudes of the elements entering differ so greatly.

In the parallel portion of the circuit, upon which E^{I} is acting, the impedance of O′O is only equal to one-ninth of the impedance of the circuit $O'A_3A_6O$; consequently, whatever be the electro-motive force impressed between the points O′ and O, the current which will flow through the circuit O′O will be nine times greater than the current flowing in the circuit $O'A_3A_6O$. When we come to consider the circuit OA_4A_1, we find that it has a relatively high impedance represented by nine. Taken as a whole, then, the generator E^{I} is acting upon a system, the series part of which has a high impedance, and the parallel part of which has a low impedance; consequently, the greater proportion of the power which is developed by the generator in this case will be absorbed in the series portion of the circuit embraced between the points OA_4A_1.

In treating the system graphically, we will first assume a known electro-motive force impressed at the terminals O′ and O. This electro-motive force we will represent in Fig. 112 by the vector $O'A^{I}_{0}$. In determining the current which this electro-motive force sets up in the circuit $O'A_2O$, we substitute in Equation 54 and lay off from O′ the resultant current vector $O'B^{I}_{2}$, lagging behind $O'A^{I}_{0}$ by the angle

$$\phi_2^{I} = \tan^{-1}\frac{x_2}{r_2}.$$

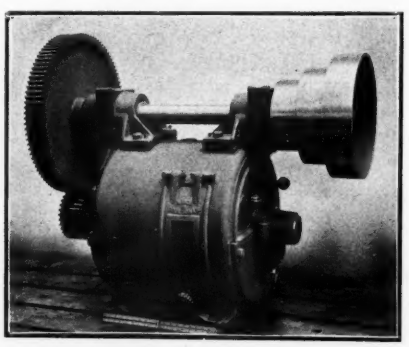
In the same way, the current which will flow through the circuit $O'A_3A_6O$ is determined by substituting its constants in Equation 54. Since the total resistance of this circuit is equal to $r_3 + r_6$, and its total reactance equal to $x_3 + x_6$ (as demonstrated on page 244 of vol. xxxviii), the current flowing in this series circuit will have a value $O'B_3^{I}$,

$$I_3^{I} = \frac{E_2^{I}}{\sqrt{(r_3 + r_6)^2 + (x_3 + x_6)^2}}$$

and it will lag behind the electro-motive force $O'A_0^{I}$ by an angle ϕ_3^{I}.

$$\phi_3^{I} = \tan^{-1}\frac{x_3 + x_6}{r_3 + r_6}$$

The current which will flow through the series circuits OA_4A_1 will be the resultant of the current vectors $O'B_2^{I}$ and $O'B_3^{I}$, or it will be equal to $O'B_1^{I}$. In completing the diagram of the electro-motive forces to determine the electro-motive force which the alternator must develop, we must lay off an electro-motive-force triangle showing the magnitude of the forces involved when this current $O'B_1^{I}$ is forced through the series circuits. Since the resistance of the series circuits OA_4A_1 is equal to $r + r_4$ and their reactance equal to $x_1 + x_4$, the value of the sides of the electro-motive-force triangle desired can be determined from Equation 54,



MAVOR & COULSON REDUCTION GEAR MOTOR, GLASGOW.

$$E_{1-4}^{I} = I_1^{I}\sqrt{(r_1 + r_4)^2 + (x_1 + x_4)^2}$$

and the phase positions of the resulting electro-motive forces graphically represented by laying off from A_0^{I} the vector

$A_0^I C_{1-4}^I$ equal to $I_1^I (r_1 + r_4)$, and at the point C_{1-4}^I erecting the perpendicular $C_{1-4}^I A^I$ equal to $I_{1-4}^I (x_1 + x_4)$. By this construction, the vector length $A_0^I A^I$ is obtained, and determines the electro-motive force required to set up the current $O'B_1^I$ in the circuits OA_4 and A_4A_1.

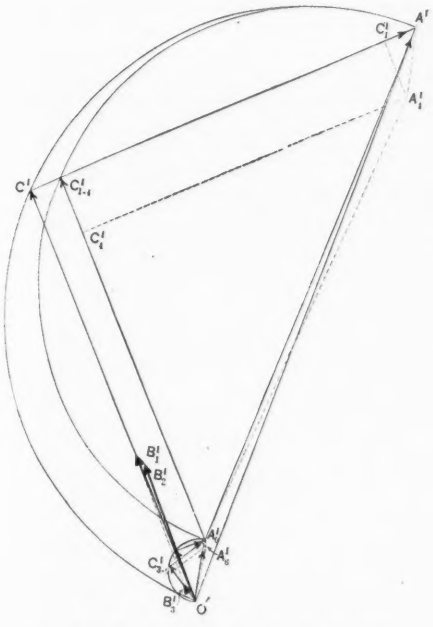


FIG. 112.—ALTERNATING MECHANISMS.

Finally, therefore, to maintain an electro-motive force equal to $O'A_0^I$ between the points O′ and O, the alternator must develop at E^I an electro-motive force equal to the resultant of $O'A_0^I$ and $A_0^I A^I$, or $O'A^I$.

Drawing $O'A^I$, the diagram is complete, and it is only necessary to combine it with a similar diagram displaced by an angle of 90 degrees, in order that the final values of the forces influencing the system when both E^I and E^{III} are active may be determined.

In Fig. 113, the latter relations are developed. Here $O'A^I$ equals the electro-motive force developed between the brush terminals at E, and $O'A^{III}$ equals the electro-motive force developed between the brush terminals at E^{III}.

$O'B_1^I$ equals the current flowing in the circuits OA_4A_1 when E_1^I only is active, and $O'B_3^{III}$ equals the current flowing in the circuits OA_4A_1 when E^{III} only is active; therefore, when both electro-motive forces are active, the current which will flow in the circuits OA_4A_1 is represented by the resultant of these current vectors, or by the vector $B_1^{III}B_1^I$.

In like manner, the current flowing in the circuit OA_3A_6, when E^I is active, is represented by the vector $O'B_3^I$, while the current developed in the circuits OA_3A_6, when E^{III} alone is active, is represented by the vector $O'B_3^{III}$; therefore, when both electro-motive forces are active, the current which will flow through the circuits OA_3A_6 is equal to the vector $B_3^I B_3^{III}$. When E^I is active, the current which flows in the circuit O′O is represented by the vector $O'B_2^I$, and when E^{III} only is acting, the current which will flow in this circuit is shown by the current $O'B_2^{III}$; when both are active, therefore, the resultant current flowing in this circuit will be equal to the resultant of $O'B_2^I$ and $O'B_2^{III}$ or $O'B_2$.

In the same way, the final electro-motive-force values appearing at the terminals of the several parts of the circuit can be found. When E^I alone is active, the electro-motive force at the terminals of the circuits OA_4A_1 will equal $A_0^I A^I$, and when E^{III} alone is active, the electro-motive force at the same terminals equals $O'A_0^{III}$. The resultant of these vector values determined by laying off from A_0^I the vector $A_0^I O$ equal to $O'A_0^{III}$ is the vector distance OA^I. The electro-motive force represented by this vector, however, must be divided between the two circuits, OA_4 and A_4A_1, in order that the part of it which is absorbed by the receiver and the part of it absorbed in the line may be ascertained.

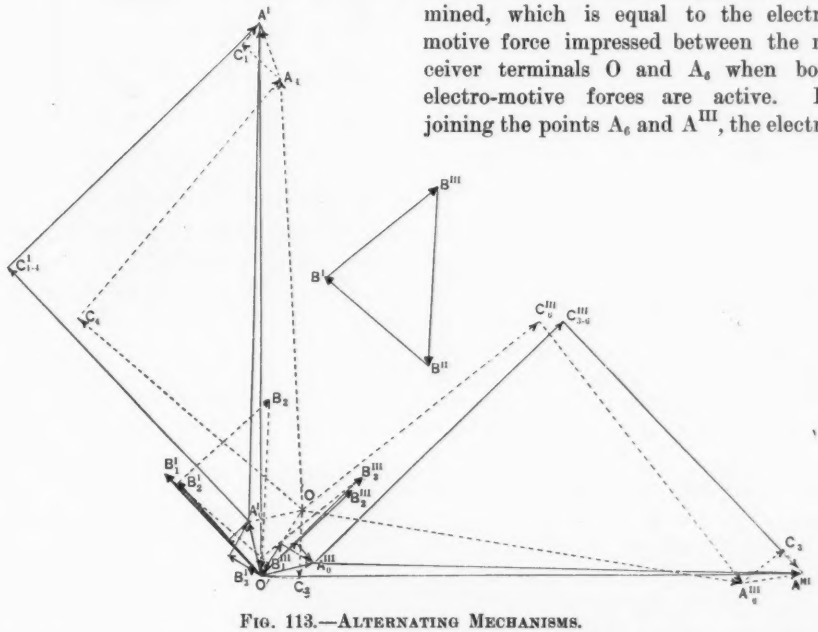


FIG. 113.—ALTERNATING MECHANISMS.

Since the phase position of the resultant current $B_1^{III}B_1^I = I_1$ is known, we can lay off from O the line OC_4 equal to $I_1 r_4$, and at C_4 erect the perpendicular $C_4A^I = I_1 x_4$. OA_4 is, therefore, the electro-motive force which finally appears between the points O and A_4. Joining A_4A^I, the vector A_4A^I represents the line drop between the points A_4 and A_4 of Fig. 3. By drawing the line A_4C_4 parallel to $B_1^{III}B_1^I$, and C_4A^I at right angles to $B_1^{III}B_1^I$, the electro-motive-force triangle of the line circuit A_4A_1 is developed.

Now, to ascertain the electro-motive force impressed at the terminals of the circuit $O'O_2$ when both generator electro-motive forces are acting, the resultant of the vectors $O'A_0^I$ and $O'A_0^{III}$ must be taken. The resultant of these gives us the vector O′O. If, now, from O we draw the line OC_2 parallel to $O'B_2$, and from O′ drop upon OC_2 the perpendicular C_2O', the electro-motive-force triangle of the line circuit O′O is determined.

Finally, the electro-motive-force distance OA^{III} is a measure of the electro-motive force impressed between the terminal points O and A_3 of the circuits OA_6A_3 when both generators are acting. If, therefore, we draw the vector OC_6 parallel to $B_3^I B_3^{III} = I_3$ and equal to $I^3 r_6$, and at C_6 erect the perpendicular $C_6A_6 = I_3 x_6$, we have the vector length OA_6 determined, which is equal to the electro-motive force impressed between the receiver terminals O and A_6 when both electro-motive forces are active. By joining the points A_6 and A^{III}, the electro-motive force absorbed in the line circuit A_6A_3 is found.

Rœntgen Rays in Smuggling.

The post office at Buenos Aires has furnished a striking illustration of the value of X-rays in detective work. Jewelers have found that smuggling in registered letters from Europe was very safe, as the government officials could not legally open such letters on suspicion, and it was finally resolved to investigate the evil without violating the law. The X-rays promptly revealed watches, chains, rings and other valuables in astonishing quantity. This evidence was sufficient for a court order to open the packages, and more than $20,000 of property has been confiscated in a single week.

THE CONSTRUCTION OF SMALL TELEPHONE EXCHANGES—XIII.*

BY A. E. DOBBS.

The floor-plan suggested in the last chapter, however, applies properly to small exchanges only, although exchanges of 2,000 lines have been built up with all outside cables terminated behind the board and only a narrow aisle between the switchboard and the cross-connecting rack which stands in front of the cable-heads. In a case prehend. To a great many subscribers a modern exchange is a wonderful sight and a rare treat, a lamp signal board being especially impressive, and the best way to cure a kicker is to invite him to come up and see just how subscribers are cared for.

Therefore, it follows that the exchange should not only be in a good location but should be an inviting place and always be in a condition to receive visitors, and, where your means will allow, always build in such a manner as to impress your subscribers with the idea that you are in busi-

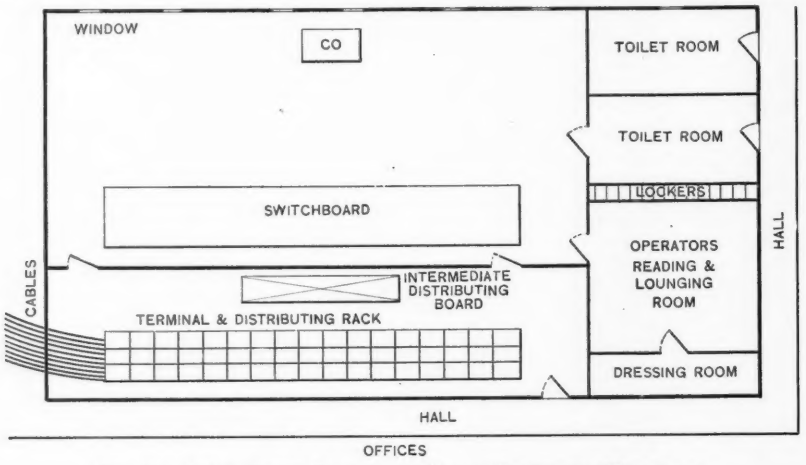


FIG. 52.—IDEAL FLOOR PLAN FOR A SMALL TELEPHONE EXCHANGE.

of this kind, however, the reason is that the system has grown much larger than was originally expected, and work of this kind makes rebuilding necessary sooner or later. Of course, a plan of this kind saves a great deal of switchboard cable, as the runs are all short, but it takes rather more jumper wire and possesses the disadvantage, that, when changes in the wiring become necessary, the wiremen have to work behind the board, where the noise they make disturbs the operators and the litter they strew around is scattered out into the room to a greater or less extent.

As a general rule, by which to be guided, no one should be allowed in the operating room except the operators, switchboard inspectors and the proper officials. This rule, however, does not apply to visitors who are always, or at least should be, accompanied by some one connected with the office, and who can thus be kept at a respectful distance from the operators, or from interfering with their work. Some exchanges have regular hours for callers on certain days of the week. Right here we might remark that visitors should be encouraged to visit the exchange as much as possible, as it puts managers and their customers in touch with each other and often explains many things to a dissatisfied subscriber that he did not before com-

ness to stay. The failure of some exchanges can be attributed to the fact that their owners did not take telephone business seriously till too late. But to return to our subject.

Fig. 52 shows an ideal floor-plan for an exchange of moderate size, say of 2,000 lines or less. It should be laid out large enough to provide for future growth. Thus, if the exchange begins business with a list of 400 subscribers, the room should be at least large enough to accommodate a switchboard of 1,000 lines capacity, and the switchboard so placed that it can be extended without disturbing existing conditions when additions are made to it.

It may be, and frequently is, thought that the exchange can not possibly grow beyond a certain size, but owners have met so many surprises in the past four years that it is not safe to set any limits to future growth, except the number of residences and business places in the town and all the surrounding country.

The room should be well lighted and cheerful, the light coming from the back of the operators as nearly as possible and the side rooms being apportioned to toilet, dressing and reading-rooms for the employés. If the room is wide enough, a partition placed behind the board separates it from the terminal and distributing racks. In an exchange of this size all terminals should be mounted directly on the distributing rack, and at least two feet left between this rack and the wall to allow the men to work on all sides of it. At least one door should be made in this partition to allow access from the terminal to the switchboard room. If the board is of the multiple type an intermediate distributing board is a great convenience in enabling the busiest lines to be assigned to the various operators, thus giving them as nearly as possible an equal amount of work. This is possible, however, only in the care of a multiple board.

INTERMEDIATE DISTRIBUTING BOARD.

The cables being brought in from the outside and cross-connected at the main distributing rack are then taken by means of cables directly to the multiple jack strips. After being carried to the multiple sections they are then continued directly back to the intermediate distributing board and connected to one side to correspond with the subscribers' telephone numbers.

So far the multiple or calling jacks have been connected to the numbers to which they belong, but now it is possible to make a change, but first let us explain. To begin, it is not necessary that the operator should know who is calling her, for she simply answers the signal that falls without regard to who is calling. Some managers even think that the less she knows about the party calling the better, for then there is no chance of favoritism in answering calls.

When she calls a party, however, she must call through the multiple strips and it follows that she must know where to find them, so these are connected to the line numbers to which they belong.

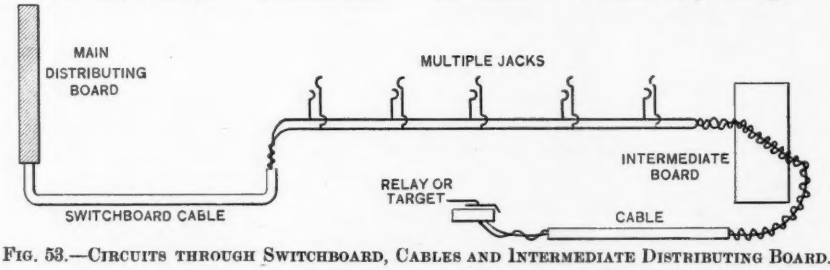


FIG. 53.—CIRCUITS THROUGH SWITCHBOARD, CABLES AND INTERMEDIATE DISTRIBUTING BOARD.

Now to return to the intermediate distributing board. It is well known that at certain hours of the day some sections of the board will be much busier than others, and the purpose of the intermediate board is to distribute these busy lines among the operators, so that each may get an equal share of the work. Thus, the line signals are distributed among the different operators and a record of the changes kept in a book, where they can be traced for further changes and for testing purposes.

After cross-connecting at this intermediate board the switchboard cables are

*Continued from No. 11, Vol. 39.

then brought back to the switchboard and connected to the subscribers' relays or answering targets, as the case may be. This intermediate board requires the use of more cable, but the distribution can be so arranged that one operator can easily take care of 200 or more subscribers without difficulty, which will pay for itself in improved service, even if there were no other consideration involved.

As the intermediate board takes a small amount of space it is often placed alongside of the main switchboard, where its capacity is not greater than 1,000 lines.

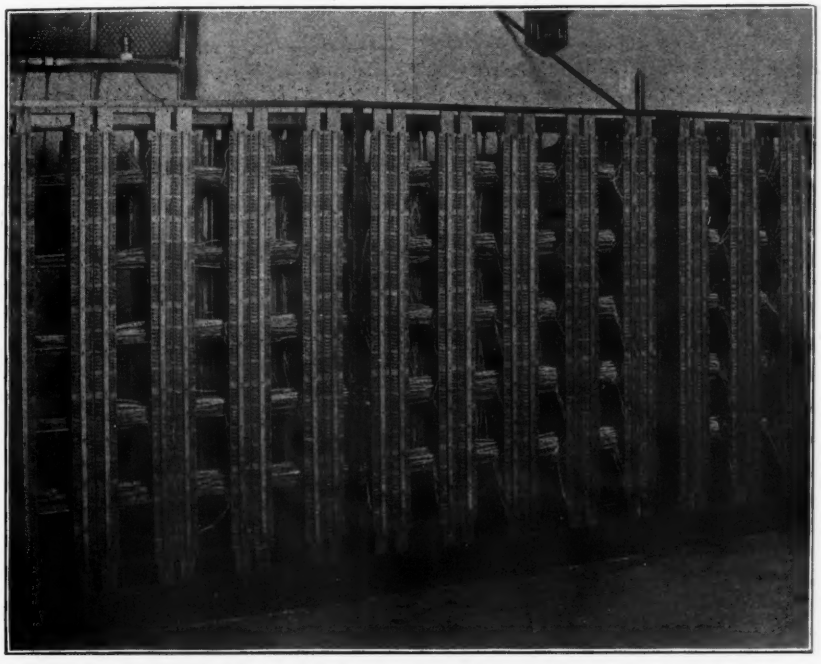


FIG. 54.—A MODERN DISTRIBUTING RACK.

This method saves a large amount of switchboard cable, but is not an improvement to the appearance of the room, even though enclosed behind closed glass doors. It is also sometimes placed at the base of the switchboard itself, but this method is rapidly being abandoned for that of making this rack a separate feature of the board.

It will perhaps be noticed that the floor plan of Fig. 52 does not make provision for battery room, power switchboard or motor-generators. This was omitted for the reason that they belong in a separate room altogether and should be in a place where the vibration from the motors or the fumes from the battery can not affect the operating room. The batteries especially should be in a room that has outside ventilation and is tightly closed from all other rooms or instruments. It also follows that the power switchboard should be in the same room as the power-generators.

Fig. 53 shows the plan of this kind of office wiring from the main distributing rack to the multiple jacks, the intermediate distributing board and back again to the relay or target signals.

Fig. 54 shows one of the latest of the forms of main distributing board.

Two racks in the room make a long loop in the cables, as will be seen by studying Fig. 53. Having spoken of the great convenience of the distribution of work among the operators, it must not be supposed that all lines are mixed up just for the sake of changing, for, on the other hand, most of them will be found connected straight through the board without any change in their line numbers, but let us suppose that one operating section of the board has 200 lines, while another has only 100. By means of the intermediate board we take away 50 lines from the former and give them to the latter girl to answer, which makes easy work for both.

Suppose, again, that the first girl has a section of the board whose subscribers will have an average of 20 calls a day, while the second has a like number of subscribers but on residence lines that do not average more than, let us say, four calls a day. In the former case we have a girl answering 4,000 calls in 10 hours, which is possible only to expert operators, even on supervisory systems, while in the latter we have a girl who only has 800 calls to answer in the same length of time. Now it is plainly evident that the latter girl could take care of at least 1,000 more calls with ease, which would greatly relieve the first one, and also facilitate the service by giving the operator a chance to breathe between calls and give less excuse for keeping subscribers waiting.

By a careful distribution of the lines it is possible to give a three-second service.

Fig. 55 shows a row of cable terminals carrying lightning arresters and heat coils, or fuses, as described in the previous chapter. In the picture shown the cable from the outside comes into the lower part of the terminal, passes through the protective devices and out to the distributing rack from the top. Where the protective devices are mounted on the cable-head the distributing rack can be made much smaller.

It will also be noticed that the cable comes into the head from beneath a false floor which should be at least six inches deep and should be placed wherever there are cables laid to protect them against mechanical injury as well as dirt. It sometimes is possible to so arrange matters that the cables can be carried in a rack overhead instead of being laid upon the floor, which for switchboard cables is better, as they will keep drier than if laid on the floor.

The most common form of switchboard cable consists of one thin layer of silk laid over a No. 22 tinned copper wire, outside of which is wrapped two layers of cotton, although one firm now makes the silk covering a little thicker and braids a single layer of cotton on the outside instead of two windings. In this case, though the insulation is not quite so thick, it is mechanically much stronger and more reliable. In order to seal these cables more thoroughly, some wiremen prefer to boil them out in a mixture of paraffin and beeswax till the fibres are completely filled. With silk insulation, however, this is a doubtful benefit, as dry silk is probably a better insulator than wax and will not absorb moisture to any great extent as a cotton insulation would. To test the quality of the silk insulation ravel out the ends and burn them with a match. Pure silk will not burn, but frizzle and curl up, while if there are any cotton threads in it they will hold the flame and a few experiments will enable one to determine if there is a mixture of cotton in the silk.

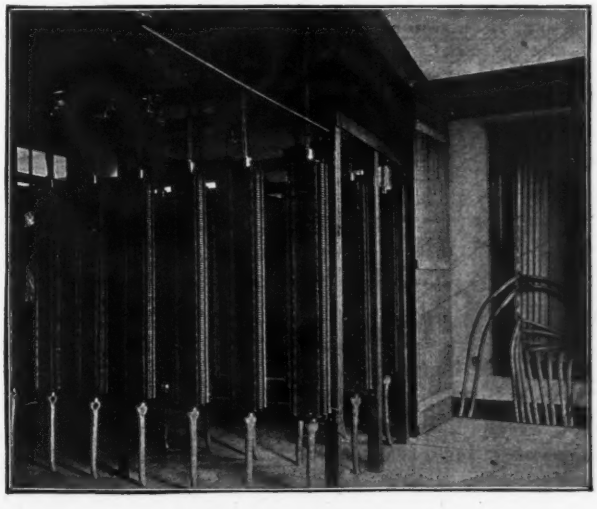


FIG. 55.—A ROW OF CABLE TERMINALS.

Electrochemical and Electrometallurgical Industry

By John B. C. Kershaw.

ARTICLE I: INTRODUCTION—PROGRESS IN THE UNITED STATES.

INTRODUCTION.

THE VALUABLE and instructive series of chapters upon "Theoretical Electrochemistry," by Professor Jones, which have appeared in the ELECTRICAL REVIEW during August and September of this year, have naturally paved the way for a series dealing with the practical applications of electricity in the production of chemicals and metals or their alloys.

It may surprise many to learn that the first practical application of electricity in the domain of metallurgy occurred nearly sixty years ago, for about the year 1845 an electromagnetic machine was built by Woolrich in England and was used by Prince, of Birmingham, for electroplating work. We are so accustomed to regard the present position of industrial electrochemistry as wholly due to the growth of knowledge in recent years, that we overlook the fact that a large number of the processes actually operated to-day were experimented with in the laboratory and works over fifty years ago.

Charles Watt, in an English patent granted in the year 1851, described forms of cell and methods of working by which metals might be extracted and refined, and salt decomposed so as to yield alkali, hypochlorites or chlorates. This patent of the year 1851 may, with some show of reason, be put forward as the master-patent of the electrochemical and electrometallurgical industries. That electroplating was the only industry which underwent development during the middle years of the century, was due to the fact that the means for producing large amounts of electric energy cheaply were non-existent at this period. In the absence of efficient dynamos, the development of other industries was impossible. The use of electricity for lighting purposes led to great improvements in both steam engines and dynamos in the years 1870 to 1890, and the utilization of water power for generation of electricity on a large scale, in the last decade of the century, finally removed the obstacle which had so long hindered the progress of these new branches of industry.

Lack of cheap power, and not lack of knowledge that the electrolytic cell could be used to produce chemicals and metals, was therefore the cause of the delay of fifty years, which passed before the work of Davy, Faraday and Watt, in this branch of science, blossomed forth into industrial fruit.

The comparatively recent work of the band of German and Dutch scientists—Arrhenius, Kohlrausch, Van't-Hoff, Nernst and others, with which Professor Jones has dwelt in his later articles, has related chiefly to the physical side of electrochemistry. Though the result of this work has changed many of the older views respecting the constitution of electrolytes and the action of the electric current, its influence upon industrial electrochemistry has not been great. The great development which has occurred in these new industries during the last thirteen years, would have been witnessed had the older views still held the field, and it is noticeable that the phraseology used in the majority of patents relating to electrochemistry is still that of the earlier investigators, Faraday and Grotthüs.

That the work of the more recent experimentalists will prove of permanent value and in time influence even industrial practice, is, of course, certain; and I have not intended by my previous remarks to disparage this work in the slightest degree. I have only been anxious to make clear the fact that the electrochemical and the electrometallurgical industries of the present moment are in the majority of instances founded upon the experimental work of men who lived in the first half of the century, whose ideas and patents fell flat during their lifetime, because there was no means of supplying cheap electric energy.

Improvements in the steam engine, the dynamo and the turbine have changed materially for the better the prospects of these new industries, and have enabled us to realize in our time the visions and dreams of the more thoughtful and far-seeing experimentalists of an earlier generation.

In industrial electrochemistry, as in other branches of human effort, it is still true that "one sows and another reaps."

PROGRESS IN THE UNITED STATES.

COPPER REFINING.

Although the electric method of refining copper was adopted in England in the year 1868, and continuously worked after that date, it was not until 1880 that the method gained an industrial footing in America. The demand for high-conductivity copper for electrical purposes, however, gave an immense impetus to this new industry between 1885 and 1895, and when the electrolytic method was once fairly established in America, its progress was rapid. The method has so often been described and is so well known that it is unnecessary to enter into any detailed description of it in this article. It will suffice to say that the crude copper is used in the form of thick slabs as anode, in a solution of copper sulphate kept slightly acid with sulphuric acid, and that when the current is passed through the cell the copper alone is deposited at the cathode, while the impurities either pass into solution or fall to the bottom of the vat as "anode sludge."

These "impurities" consist, in the case of copper smelted from pyritic ores, chiefly in silver and gold, and as their recovery from the anode sludge is comparatively simple and costless, the value of the recovered impurities often covers the whole cost of the refining process.

The developments of the electrolytic refining industry in the United States of America have been marvelously rapid. In 1888 only three refining companies of any importance were at work—namely, the Balbach Smelting and Refining Company, at Newark; the Baltimore Smelting and Rolling Company, at Baltimore, and the Bridgeport Copper Company, at Bridgeport.

In 1893 the number of electrolytic refineries had increased to thirteen, and the output to 45,000 tons of copper per annum. Since that date several of the smaller refineries have been closed, but, on the other hand, the capacity and the output of the eight surviving refineries have been enormously increased. The amount of electrolytic copper produced by one refinery—namely, that of the Anaconda Mining Company—is now greater than the total output of the European refineries, and in 1900 the aggregate capacity of the American refineries was estimated by Ulke to amount to 211,000 tons per annum.

The United States of America output of raw copper in 1900 was 268,000 tons, so that plant exists for dealing with no less than eighty per cent of this total output by the electrolytic method.

The eight electrolytic copper refineries now existing in the United States are situated at Baltimore; Newark; Great Falls, Mont.; Anaconda; Bridgeport; Brooklyn; Salt Lake City and Perth Amboy. The

refineries of the Guggenheim Company, at Perth Amboy, and of the Anaconda Mining Company, at Anaconda, are the most important.

The multiple, or Thofehrn, system of working the vats is usually employed, and with one exception all the plants are worked by steam power. The cost of power, compared with the value of the product, is so small an item in this industry that no advantage can be gained by locating a refinery near a large water power.

ALUMINUM.

The production of aluminum in America by electrometallurgical methods dates from 1886. In that year the Brothers Cowles established a works for the production of alloys of aluminum with copper in the electric furnace at Lockport, and this factory was operated until 1892, when various causes led to it being shut down.

In 1888 Hall commenced to manufacture the metal—aluminum—by a method which he had workd out and patented, at Pittsburgh, and this process of aluminum reduction has been worked continuously since that date by the Pittsburgh Reduction Company—first at New Kensington and later at Niagara.

The processes of two other inventors—namely, Heroult and Wilson—have been worked for short periods in America—in the years 1889 and 1890, and 1894 and 1895, respectively—but these did not result in any permanent success, and the Pittsburgh Reduction Company is now the only company producing the light metal in America.

The output of aluminum by this company has enormously increased since the removal of the reduction works from New Kensington to Niagara in 1895. In 1890 the total production of aluminum in the States amounted to only twenty-seven tons, and the total world production to 174 tons. In 1895 the American production had increased to 379 tons, while in 1900 it is stated to have amounted to 3,190 tons, divided between the two Niagara factories of the Pittsburgh Reduction Company, and 10,000 horse-power is now available for this manufacture.

The fall in price which has accompanied the great increase in output is no less remarkable. In 1889 aluminum was selling for $2.50 per pound in the United States of America. In 1896 the price had dropped to forty-five cents per pound, and in 1898 the Pittsburgh company commenced to sell aluminum for special purposes for twenty-nine cents per pound.

The method worked out by Hall by which aluminum is reduced from its oxide, differs little from that used in Europe and patented under the name of Heroult.

A purified form of alumina is continuously charged into a bath containing fused cryolite, and the molten mass is submitted to the action of an electric current, using carbon electrodes. The aluminum separates at the cathode, in the molten condition, and is drawn off at stated intervals from the bottom of the bath. It is usual to make use of the electric current for maintaining the bath in the liquid condition, and to use the carbon lining in the bath or "pot" as cathode in the operation of the process.

Limits of space will not permit of any detailed enumeration of the applications of aluminum in the arts and industries. During the last two years the greater portion of the output of the Niagara factories has been utilized for electrical purposes, and there are a considerable number of aluminum transmission lines now in operation in the western states. The latest example of this use of aluminum is the new line for transmitting Niagara power to Buffalo. So far, these aluminum lines have given satisfaction, but time will alone show whether aluminum possesses all the characteristics required to render it a satisfactory substitute for copper in power-transmission schemes.

ALKALI AND CHLORINE.

The first electrolytic alkali factory in the United States of America was erected by the Electrochemical Company, at Rumford Falls, in 1892, and the Le Sueur process was operated at this factory until 1899 with varying success. These works had 1,000 horse-power available for the manufacture, but at no period was the whole of this power utilized. In 1900, the factory at Rumford Falls was shut down and the cells and other plant transferred to the Berlin Falls factory of the Burgess Sulphite Fibre Company. The Le Sueur process, with certain modifications, is still employed by this company, and I am informed that 700 horse-power is now used in the manufacture of caustic alkali and bleaching solutions, with fairly satisfactory results. These products are, however, utilized in the wood-pulp manufacture at Berlin Falls, and are not placed upon the market.

In 1897 the Mathieson Alkali Company commenced to operate the Castner cell and process for the production of caustic alkali and chlorine at Niagara Falls, and the works were gradually enlarged until 2,000 horse-power was utilized in this manufacture. The Castner Electrolytic Alkali Company was formed in 1900 to take over and extend the Mathieson company's factory, and plant equivalent to 4,000 additional horse-power is being put down. When the enlargements are completed these works will be the largest electrolytic factory in the world. The capital of the new company is $3,000,000.

The American Alkali Company and the Ackers Process Company are two other companies which have been recently floated for the purpose of carrying on the manufactures of alkalies and chlorine compounds by the electrolytic method. The works are located at Sault Ste. Marie and Niagara Falls, and the processes to be used are patented under the names of Rhodin and Ackers, respectively.

These new works are to be in operation in 1901, but I am not able to state whether the expectations of the promoters as regards the starting of the works have been fulfilled. However, by the end of the year it is probable that 7,700 horse-power, all generated from water, will be utilized in the United States of America for alkali and chlorine manufacture.

It is not possible in this article to give any detailed description of the different cells used in the above four works for decomposition of sodium chloride by the electric current. The Castner and Rhodin cells are somewhat similar, for both are kept in mechanical movement, and mercury is used as the cathode metal. The Le Sueur cell is a stationary one, a diaphragm is used to separate the anode and cathode compartments, and carbon is used as cathode material. The Ackers process differs from the others in making use of fused sodium chloride, in place of an aqueous solution of the same, as electrolyte. The construction of the cell is governed by the fact that a high temperature has to be maintained during the electrolysis, and that molten lead is employed as cathode. A similar process has been operated on an industrial scale in France with disappointing results, and the plant is now shut down, but possibly Ackers may overcome the special difficulties that have caused failure in France. The mechanical difficulties met with in successfully operating a fusion process for the production of alkalies and chlorine are, however, exceptionally great.

REMAINING MANUFACTURES.

Limits of space will only permit a very brief summary of the remaining electrochemical and electrometallurgical processes now in operation upon a commercial scale. Calcium carbide is manufactured at Niagara Falls, at Sault Ste. Marie and at Appleton, but the output of this product in the United States of America is now practically in the hands of the Union Carbide Company, which is stated to have plant equivalent to 10,000 horse-power available for this manufacture at Niagara Falls. Chlorates of potash and soda are manufactured at Niagara Falls and at Bay City—the factory at the latter place being operated by steam power. About 3,000 horse-power is believed to be utilized in the three factories engaged in this manufacture.

Nickel has been electrolytically refined at Newark since 1894, and experimental trials are now being carried out at Niagara with a nickel extraction process patented by Frasch. A third electrolytic process for nickel production is said to be in operation at Cleveland. Very few details of these processes have been published, and the horse-power utilized in the production of nickel by electrometallurgical processes is a problematical figure.

SYNCHRONISM AND FREQUENCY INDICATION—II.

BY PAUL M. LINCOLN.

This result can be effectually obtained by inserting a capacity in series with the inductance of the field. The phase relations between the electro-motive force and currents in the armature remain practically unchanged with varying frequency while under the above condition; that between the electro-motive force and current in the field, plus the added capacity, is sensitive to frequency change. The angular position assumed by the armature is an indication of the phase relation between currents in field and armature, and is therefore a measure of frequency. Assuming then that an angular movement of the armature always represents an equal angular shift of phase between currents in it and the field, it is only necessary to determine the phase change in the field for a given frequency change to obtain a complete calibration of this frequency indicator.

Fig. 3 gives for a number of different conditions, the relations between frequency and phase angle in circuits containing inductance, capacity and resistance. These curves show that the most rapid change of phase angle for a given frequency change occurs at the point where the phase angle is 0.

When phase angle is 0, resonance exists; that is, the capacity ohms at that point are equal to the inductive ohms. It will be interesting to determine how great a frequency change is indicated by a given phase angle change both at the point of resonance as well as at other points in the cycle.

The relation between phase angle and frequency is given by

$$(21) \qquad \tan \varphi = \frac{1}{C R \omega} - \frac{L \omega}{R}$$

In which

φ = phase angle.
L = inductance in henrys.
C = capacity in farads.
R = resistance in ohms.
$\omega = 2 \pi \times$ frequency in cycles per second.

The sensitiveness of the instrument is the ratio of the phase change which takes place for a small frequency change and expression for sensitiveness may be obtained by differentiating (21)

$$(22) \qquad \frac{d \varphi}{d \omega} = - \cos^2 \varphi \left(\frac{1}{CR \omega^2} + \frac{L}{R} \right) = \frac{CR (1 + CL \omega^2)}{(1 - CL \omega^2)^2 + C^2 R^2 \omega^2}$$

Resonance occurs when

$$\omega^2 = \frac{1}{CL}$$

and if this value be substituted in (22) it becomes

$$(23) \qquad \frac{d \varphi}{d \omega} = - \frac{2 L}{R}$$

This is the expression for sensitiveness at the point of resonance, at which point it reaches a maximum. The angular change in degrees for a one-per-cent change in frequency at resonance is

$$\frac{7.2 L n}{R}$$

in which n is frequency in cycles per second.

The usual service required of a frequency indicator is the measurement of the small variations from normal frequency or speed which take place under ordinary operating conditions. For this purpose the instrument herein described is peculiarly well adapted. The capacity and inductance in the field circuit, both of which are capable of accurate measurement, can be so chosen that resonance is produced at normal frequency. That is, they should be chosen so as to satisfy the equation:

$$(2 \pi n_0)^2 = \omega_0^2 = \frac{1}{CL}$$

where n_0 is the normal operating frequency. The instrument will, under these conditions, be used at a point where its sensitiveness is a maximum.

Sensitiveness, however, is not the only requisite in the design of a frequency indicator. Its range is a matter which deserves a share of attention. Considering (21) it is evident that when $\omega = 0$, $\varphi = + 90°$, and when $\omega = \infty$, $\varphi = - 90°$.

All frequencies of positive sign are therefore included in this total range of 180 degrees. Of this total range, however, only in that portion between the limits

$$(24) \qquad \varphi = \tan^{-1} \pm \sqrt{\frac{L \omega_0}{L \omega_0 \pm R}}$$

is the sensitiveness above one-half the maximum. The corresponding limits for the frequency are given by

$$(25) \qquad \omega = \sqrt{\omega_0^2 \pm \frac{R}{L} \omega_0}$$

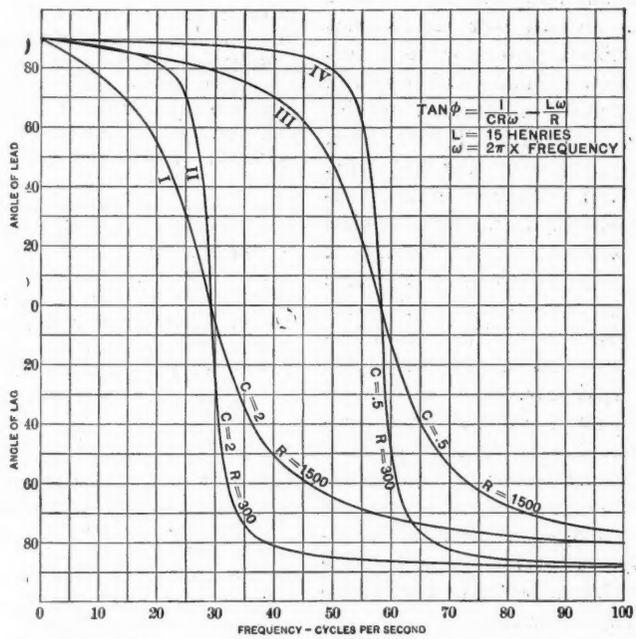


FIG. 3.—CURVES SHOWING RELATIONS BETWEEN FREQUENCIES AND PHASE ANGLE.

That portion of the scale between these two limits may be taken as the working range. This working range occupies approximately 90 degrees of the scale extending from approximately plus 45 degrees to minus 45 degrees. The frequency included between these two limits is approximately expressed by

$$\frac{R}{2 \pi L}$$

As might be expected, the expressions for sensitiveness and range are reciprocal quantities; as one increases the other decreases.

So far we have been proceeding on an assumption of the use of a perfect phase meter; that is, one whose phase angle changes are exactly reproduced by mechanical angle changes the same in amount.

It was proposed to secure an appropriation from the New York Legislature to establish a school of electricity at Schenectady in connection with Union College, but the measure has been defeated. Provided the same amount is obtained from other sources the General Electric Company has agreed to give $12,500.

THEORETICAL INVESTIGATION OF SOME OSCILLATIONS OF EXTREMELY HIGH POTENTIAL IN ALTERNATING HIGH POTENTIAL TRANSMISSIONS—I.*

BY CHARLES P. STEINMETZ.

In the following I intend to give a section of a series of investigations extending over some years, on the effect of the exponential term in the general equation of alternating current.

If a sine-wave of electro-motive force is impressed upon a general electric circuit containing resistance, inductance and capacity, the ultimate current is a sine-wave also. In the moment of closing the circuit, however, or in any other way changing the circuit conditions, upon the sine-wave of current an exponential term is superimposed, of the general character:

$$\Sigma\, A_1 \epsilon^{-a_1 \varphi}$$

In a single circuit containing only resistance r and inductive reactance x, only one exponential term

$$A\, \varepsilon^{-\frac{r}{x}\varphi}$$

appears. In a system of such circuits, directly or inductively connected with each other, a series of exponential terms appear, the exponents of which are determined as the roots of an equation of nth degree.

If, however, a circuit contains resistance, inductance and capacity in series, two exponential terms

$$A_1\, \varepsilon^{-a_1 \varphi} + A_2\, \varepsilon^{-a_2 \varphi}$$

exist, where a_1 and a_2 are the roots of a quadratic equation, and either real or complex imaginary. In the latter case the exponential term resolves into the form:

$$\varepsilon^{-b\varphi}\left\{B_1 \cos \varphi + B_2 \sin \varphi\right\}$$

an electric oscillation.

With several circuits of general character connected with each other directly or inductively, a series of exponential terms

$$\Sigma\, A_1\, \varepsilon^{-a_1 \varphi}$$

appear, in which the exponents a_1 are the roots of an equation of $2n$th degree, which, when complex imaginary, give electrical oscillations, and the coefficients A_1, depend on the initial conditions of the circuits. Thus in such a system of circuits a number of superimposed oscillations may occur, of different frequencies and intensities.

Under certain conditions by such oscillations caused by a change of circuit conditions, destructive voltages may be produced. The first time I noticed such a phenomenon was when making a series of observations on the effect of opening a high-potential circuit with different types of circuit-breakers, on an artificial line consisting of inductive coils and about half a mile of high-potential cable, with a spark-gap between needle-points connected across the system, to measure an instantaneous rise of voltage. If the needle-points were brought so close together that a discharge occurred between them, invariably by the short-circuiting of the system across the needle-points, an extremely high voltage was induced locally in the system, of a total striking distance reaching as high as 40 inches, that is between one-quarter and one-half million volts, the normal voltage of the system being about 10,000.

The phenomenon is probably as follows: By striking between the needle-points shunting the circuit, the system was short-circuited and thus instantly drained of its electrostatic charge, so that the potential locally fell to practically nothing, while an excessive current passed between the needle-points as arc. By the heating effects of this current the arc was instantly blown out explosively and thus the short-circuit current of the system ruptured. After the explosion the discharge between the needle-points again short-circuited, interrupted itself, etc. The phenomenon is thus of similar character, but infinitely greater power, as the action of the Wehnelt interrupter (the latter depending upon the combined effect of self-induction and electrolytic polarization, while the phenomenon I observed occurred with self-induction and capacity).

Since that time in a number of instances of high-potential circuits electrical discharges were noticed, of striking distances many times greater than that of the normal potential of the system, under circumstances where a short-circuiting arc interrupted itself in the open air. A short-circuit in a constrained space, as a buried cable, does not appear to give this effect.

From this and other reasons I was led to believe that a short-circuiting high-potential arc in free space, in a system containing self-induction and capacity, is a self-interrupting phenomenon, and thus may cause very serious high-potential effects. On any high-potential limited-power transformer this phenomenon can be observed by an entire change of the character of the arc between the high-potential terminals when inserting capacity in shunt. From the flame of the steady and noiseless arc, which curves upward by its heat, the discharge changes to the glaring white, noisy, lightning-like, destructive, high-potential oscillation. This change can be shown photographically, the photographs giving in the former case, that is absence of capacity, the striations of the successive half waves of the impressed frequency, while in the latter case they show a system of successive electrostatic sparks not followed by the striated alternating arc flame. As shown by Mr. W. S. Andrews, a number of oscillating discharges may occur during the same half wave of alternating primary electro-motive force.

The investigation of the character of electric oscillation produced by a short-circuiting and self-interrupting arc is the purpose of the following. The bearing of this phenomenon on high-potential engineering is obvious.

If in a transmission line of impressed voltage $e = E \cos(\varphi - \omega)$ carrying current $I \cos(\varphi - \omega - \delta)$, the circuit is opened at the receiving end, there remain in circuit the line capacity in series with the resistance and inductance of step-up transformers, etc., and a part of the line.

Let, as an approximation, the line capacity be represented by a condenser shunted across the centre of the transmission line, and let:

r = resistance,

L = inductance, thus: $x = 2\pi NL$ = reactance of circuit between constant-potential generator bus-bars and line capacity (reduced to the line voltage).

Let:

C = capacity, thus: $k = \frac{1}{2\pi NC}$ = capacity reactance of line.

Let now the circuit be opened at the moment: $t = o$, or: $\varphi = o$, and at the moment when the circuit is opened:

e_0 = potential difference at line condenser,

i_0 = current in line.

If: i = instantaneous value of current at time t, it is: Electro-motive force consumed by self-induction:

$$L\frac{di}{dt}$$

Potential difference at condenser terminals:

$$e_1 = \frac{1}{C}\int i\, dt$$

Thus the differential equation of the phenomenon is:

$$e - ir - L\frac{di}{dt} - \frac{1}{C}\int i\, dt = o$$

or, substituting:

$$\varphi = 2\pi N t,$$
$$e = E \cos(\varphi - \omega)$$

* A paper read before the American Institute of Electrical Engineers, Buffalo, August 23, 1901.

it is:

$$E\cos(\varphi-\omega)-ir-x\frac{di}{d\varphi}-k\int i\,d\varphi=0 \qquad (1)$$

and:

$$e^1=k\int i\,d\varphi=E\cos(\varphi-\omega)-ir-x\frac{di}{d\varphi} \qquad (2)$$

Equation (1) differentiated:

$$E\sin(\varphi-\omega)+k\,i+r\frac{di}{d\varphi}+x\frac{d^2i}{d\varphi^2}=0 \qquad (3)$$

This differential equation of second order is integrated by:

$$i=A\,\varepsilon^{-a\varphi}+B\cos(\varphi-\sigma) \qquad (4)$$

Substituting (4) in (3) gives:

$$(a^2x-ar+k)\,A\,\varepsilon^{a\varphi}+\sin(\varphi+\sigma)\,[E\cos(\sigma-\omega)-rB]$$
$$+\cos(\varphi-\sigma)\,[E\sin(\sigma-\omega)-(x-k)\,B] \qquad (5)$$

Hence:

$$\left.\begin{aligned}&a^2x-ar+k=0\\&E\cos(\sigma-\omega)-rB=0\\&E\sin(\sigma-\omega)-(x-k)\,B=0\end{aligned}\right\} \qquad (6)$$

$$A=\text{indefinite},$$

and herefrom:

$$\tan(\sigma-\omega)=\frac{x-k}{r}$$

or, by denoting:

$$\tan a=\frac{k-x}{r} \qquad (7)$$

where a is a constant of the circuit,

$$\sigma=\omega-a \qquad (8)$$

Further:

$$B=\frac{E}{\sqrt{r^2+(x-k)^2}}$$

or, denoting:

$$z_0=\sqrt{r^2+(x-k)^2} \qquad (9)$$

where z_0 is a constant of the circuit,

$$B=\frac{E}{z_0} \qquad (10)$$

and a is, as root of quadratic equation:

$$a=\frac{r\pm\sqrt{r^2-4xk}}{2x}$$

Since the inductive reactance x is of the same magnitude as the resistance r, the capacity reactance k, however, that is the reactance of the line as condenser, of higher magnitude than r or x, it is always:

$$4xk>r^2$$

that is,

$\sqrt{r^2-4xk}$ is imaginary

Substituting:

$$q=\sqrt{4xk-r^2} \qquad (11)$$

it is:

$$a=\frac{r\pm jq}{2x} \qquad (12)$$

and the integral equation of the problem is:

$$i=A_1\,\varepsilon^{-\frac{r+jq}{2x}\varphi}+A_2\,\varepsilon^{-\frac{r-jq}{2x}\varphi}+\frac{E}{z_0}\cos(\varphi-\omega+a) \qquad (13)$$

that is:

$$i=\varepsilon^{-\frac{r}{2x}\varphi}\left\{A_1\,\varepsilon^{-j\frac{q}{2x}\varphi}+A_2\,\varepsilon^{+j\frac{q}{2x}\varphi}\right\}+\frac{E}{z_0}\cos(\varphi-\omega+a)$$

Substituting the trigonometric expressions:

$$\left.\begin{aligned}&\varepsilon^{+j\frac{q}{2x}\varphi}=\cos\frac{q}{2x}\varphi+j\sin\frac{q}{2x}\varphi\\&\varepsilon^{-j\frac{q}{2x}\varphi}=\cos\frac{q}{2x}\varphi-j\sin\frac{q}{2x}\varphi\end{aligned}\right\}$$

and rearranging, it is:

$$i=\varepsilon^{-\frac{r}{2x}}\left\{(A_1+A_2)\cos\frac{q}{2x}\varphi-j\,(A_1-A_2)\sin\frac{q}{2x}\varphi\right\}+\frac{E}{z_0}\cos(\varphi-\omega+a)$$

or, substituting:

$$\left.\begin{aligned}&A_1+A_2=C_1\\&j\,(A_1-A_2)=C_2\end{aligned}\right\}$$

it is:

$$i=\varepsilon^{-\frac{r}{2x}\varphi}\left(C_1\cos\frac{q}{2x}\varphi-C_2\sin\frac{q}{2x}\varphi\right)+\frac{E}{z_0}\cos(\varphi-\omega+a) \qquad (14)$$

where C_1 and C_2 are determined by the circuit conditions at $t=0$.

The potential difference at the condenser terminals is, by substituting (14) in (2):

$$e_1=\varepsilon^{-\frac{r}{2x}\varphi}\left\{C_1\left(\frac{q}{2}\sin\frac{q}{2x}\varphi-\frac{r}{2}\cos\frac{q}{2x}\varphi\right)+C_2\left(\frac{q}{2}\cos\frac{q}{2x}\varphi+\frac{r}{2}\sin\frac{q}{2x}\varphi\right)\right\}$$
$$+E\left\{\cos(\varphi-\omega)-\frac{r}{z_0}\cos(\varphi-\omega+a)+\frac{x}{z_0}\sin(\varphi-\omega+a)\right\}$$

or, substituting:

$$\frac{r}{z_0}=\cos a\quad\frac{x}{z_0}=\frac{k}{z_0}+\sin a:$$

$$e_1=\varepsilon^{-\frac{r}{2x}\varphi}\left\{C_1\left(\frac{q}{2}\sin\frac{q}{2x}\varphi-\frac{r}{2}\cos\frac{q}{2x}\varphi\right)+C_2\left(\frac{q}{2}\cos\frac{q}{2x}\varphi+\frac{r}{2}\sin\frac{q}{2x}\varphi\right)\right\}$$
$$+\frac{k}{z_0}E\sin(\varphi-\omega+a) \qquad (15)$$

THE ELECTRIC TRANSMISSION OF POWER FROM NIAGARA FALLS—I.*

BY LEWIS B. STILLWELL.

INTRODUCTION.

The history of the Niagara Falls power-plant is a demonstration of the ability of applied electrical engineering science to attain in commercial practice results predicated in large degree upon theory. In a most striking manner, it exhibits the fact that for nearly a decade electrical engineering has been established upon a basis as certain and permanent as other branches of engineering; that eight years ago—a long time in our profession—it was possible to so plan an electrical installation involving ultimately the transmission and distribution of several hundred thousands of horse-power that at the present time we can effect in improvement only with respect to relatively unimportant details, the aggregate results of which, if adopted, would be hardly noticeable as affecting the cost of power. I think it safe to say that if the Niagara Falls Power Company to-day were facing the same problem which it solved in 1893 and should bring to bear upon it the same comprehensive and thorough-going methods which at that time characterized the work of its officers and directors, its solution, based upon all that has been learned up to the present time, would be so nearly identical with the solution which it adopted eight years ago that the resulting cost of power delivered to local users would not be affected even to the amount of one dollar per kilowatt year.

These facts are perhaps in no sense surprising to members of this Institute, but the general public, and even many men of broad intelligence and large affairs, unquestionably still have a feeling that electrical engineering is in large degree experimental, and that capital invested in electrical enterprises to-day may vanish to-morrow by reason of some new invention. It is surely important to establish confidence in the certain and permanent character of adequate electrical engineering, and I shall ask you to consider the Niagara plant with special reference to two thoughts; *viz.*, (1) How does the plant as it now stands completed differ from the plans contemplated in October, 1893, when the original contract for electrical machinery was closed; and (2) What has experience in the construction and operation of the first plant suggested in the way of further improvement? The history of the plant considered with these thoughts in mind constitutes a forceful reply to the statement so often made that "electricity is in its infancy," and should go far to establish confidence in the ability of electrical engineering science to predict with accuracy results that are reasonably certain to be realized in practice.

In saying that if the Niagara Falls Power Company in 1901 were facing the problem which it solved in 1893, the solution now would be substantially identical with the solution then—I am not saying that there has been no important improvement in electrical methods and machinery during the last eight years. Undoubtedly the art has advanced; methods of manufacture, by reason of accumulated experience and improved facilities, are far more satisfactory now than they were then. Our knowledge of theory, particularly the theory of alternating currents, is relatively far more complete, but progress in alternating-current methods since 1893 has been in no sense revolutionary, and the time has long since passed when capital might reasonably hesitate to embark in well-considered enterprises depending for success upon a correct application of electrical engineering skill. It is a significant fact that the electrical machinery to be installed in the second power-house now under construction will differ from that now in use in power-house No. 1 with respect only to details of construction, relatively unimportant, while nearly every constituent part of the hydraulic equipment of the new plant will be materially and even radically different from its predecessor.

It has been said that electricity as a science is only less exact than astronomy, but the fact that a science is exact by no means implies that there is but one reasonable way of applying it to the solution of an engineering problem. Naturally, in electrical engineering, as in other departments of human endeavor, several roads often lead to practically the same goal, and were a Niagara problem to be presented for solution to-day to the members of this Institute, I have no doubt that the plans proposed would exhibit sufficient variety to remove all fear that practice is liable to become so "standardized" as to leave no room for originality, new ideas and consequent progress, but I imagine that the plans proposed, while varied, would be by no means so widely divergent as they would have been in 1893. To the business man without technical training who may venture to read the discussion of a subject like this by an engineering society, the natural divergence of individual views expressed with respect to frequency, potential and all the rest must convey the impression that there is no such thing as established lines of practice, but when these differences of opinion are expressed in concrete units of cost it is apparent that considerable variety of detail in plan and construction may be consistent with attainment of the same practical result.

II—THE PROBLEM PRESENTED.

The wisdom or unwisdom of the plans adopted in 1893, upon which we now have the additional light of eight years' extraordinary activity in both theoretical and practical work, must be judged with reference to the conditions and requirements of the market for power then assumed rather than with reference to the requirements of the market as now actually developed. It was expected in 1893 that a very large proportion of the power developed would be utilized by motors in mill and factory work. With regard to the local use of power at Niagara, this anticipation has not been realized and even in Buffalo more than half the Niagara power used is utilized in operating the street railway and lighting systems.

In a descriptive memoir which I drew as electrical engineer of the Westinghouse company, and which was submitted to the Cataract Construction Company under date of February 6, 1893, my understanding of the problem presented was stated as follows:

We are to lay out a system that will enable you to take energy at the upper end of vertical shafts making 250 revolutions per minute, each shaft delivering 5,000 horse-power, and to deliver in saleable and reliable form the largest practical and economical percentage of this energy; 1, within the limits of Cataract City, distance not exceeding two miles; 2, at the northern boundary of the city of Buffalo; 3, at more distant points; *e. g.*, New York and Chicago.

In each of the above cases energy is to be delivered in form available for:

1. Power purposes.

(*a*) General mill and factory work, pumping stations, etc.; units of from 10 to 1,000 horse-power.

(*b*) Operation of street railways; units of from 100 to 1,000 horse-power.

(*c*) Miscellaneous work in factories, mills, the operation of elevators, printing-presses, etc.; units, 1 to 25 horse-power.

2. Lighting purposes.

(*a*) Arc lights.

(*b*) Incandescent lamps.

3. Electrolytic purposes.

It is proposed to ultimately locate twenty-five 5,000-horse-power turbines at the power-station on the American side of the river, and upon the Canadian side of the river an as yet undetermined number of units of equal size. The distance between the power-stations, by way of the Suspension Bridge, is two and one-half miles, and it is desired

* A paper read before the American Institute of Electrical Engineers at Buffalo, August 23, 1901.

to provide electrical connection between the stations so that the generating apparatus in one station may in time of emergency be substituted for that in the other.

While the above stated capacities are to be ultimately installed, the immediate requirements are limited to three generating units of 5,000 horse-power each, with whatever apparatus may be needed in connection therewith, first, to transmit and distribute energy within the limits of Cataract City; second, to transmit energy to a substation located at the northern boundary of Buffalo.

For electrolytic and power purposes the capacity of at least one machine will soon be called for at the manufacturing centre, Echota, situated 7,000 feet from the power-station on the American side of the river within the limits of Cataract City; from 200 to 300 horse-power will be needed for the operation of an electric freight and passenger railway, extending from the power-house by way of Echota to a junction with the New York Central Railway, situated near the northeastern limits of the new city of Niagara Falls.

It is proposed to employ one or two generators to supply power to a substation at the northern limit of Buffalo. The amount supplied will depend upon the market for power, and the system selected must be such as will admit of ready and symmetrical increase with the growth of the demand. As stated by Mr. Adams, the principal purposes for which power is now used in the city of Buffalo, with the approximate amounts for each, are:

	Horse-Power.
Pumping	4,000
Operation street railways	3,000
Arc lighting	3,500

In addition to this about 1,000 horse-power is used to supply incandescent lamps, and there is also a considerable amount of power used for miscellaneous purposes in factories and mills.

The ability to reach more remote markets for power—as, for example, the cities of New York and Chicago—will depend upon the practicability of properly insulating the conductors used for the transmission of currents. Recent progress in this direction has been such as already makes our available radius of transmission greatly exceed the distance between the power-station and the city of Buffalo, and it is desirable that the system selected should be such as will lend itself to future transmission over very great distances.

In considering the above requirements we note, first, that the conditions impose the following as necessary characteristics of the system:

1. Alternating currents for transmission.
2. Direct currents for electrolytic work.
3. Direct currents for street railway purposes.

For general power purposes, and for arc and incandescent light, the conditions are not restrictive, and we may use either alternating current or direct current. But while both alternating and direct currents are needed, it is in the highest degree desirable that the system should be so laid out as to admit uniformity in size and type of generators. This feature in an installation is of the greatest value, as it allows ready substitution of one generator for another when for any reason such substitution becomes desirable. It implies also uniformity in auxiliary station apparatus, and a symmetry of system which is invaluable in the practical operation of the plant.

III—THE SYSTEM ADOPTED.

The system chosen to meet the complex, and, up to that time, unprecedented requirements was the alternating-current system using two-phase alternators wound for 25 cycles per second and 2,200 volts. It was adopted by the Cataract Construction Company as the result of a most comprehensive and painstaking investigation conducted under the personal direction of Mr. Edward D. Adams, president of the Cataract Construction Company, assisted at every step from the inception of the enterprise by Dr. Coleman Sellers as his chief engineering adviser. It was adopted, notwithstanding the fact that some of the greatest scientists of the day advised against the use of alternating current and in favor of direct current. That the directors of the company in 1893 selected a system substantially identical with that which they would undoubtedly choose to-day to meet a similar problem is due in very large degree to the great ability and conscientious care of that grand old American engineer, Coleman Sellers, of Philadelphia, himself not claiming special knowledge of electricity, but possessed of vast experience in engineering science in many fields and excellently qualified to judge both electricians and their works. The Cataract Construction Company, from the time when the directors and Dr. Sellers seriously began their study of the problem of utilizing Niagara power, in 1889, to the time of closing the contract with the Westinghouse Electric Company, of Pittsburgh, Pa., for the first three alternators, arrived at six important decisions with respect to engineering practice. These decisions were: (1) To use a central power-station and a system of electrical power distribution, "as the chief means of distributing the power, though perhaps not the only means;" (2) to adopt a uniform system for both local and long-distance transmission; (3) to use the alternating-current system; (4) to reject the three-phase system; (5) to adopt a frequency of 25 cycles per second; (6) to use alternators wound for about 2,000 volts and step-up transformers for transmission to points not economically reached by the potential generated.

The decision to use a central power-station developing power in large amounts by turbines located in a limited number of large wheel pits and to distribute power electrically instead of adopting the plan originally considered, which contemplated an exclusively hydraulic development as generally adopted prior to that time in the development of water power for manufacturing purposes, was undoubtedly wise. To-day, in new plants, the utilization of water power is almost invariably accomplished by means of electrical distribution.

To adopt the alternating and not the direct-current system was also undoubtedly wise. In 1893, however, there were still many who believed that the direct-current system possessed superior advantages, but the development of the art of transmitting and distributing power has long since practically settled this question. There is nothing in the work of Thury or others who have attempted to utilize continuous currents at high potential for long-distance transmission that would lead us to question the superiority of the alternating-current system for long-distance transmission of power. The transformer is the key to the solution of this problem which those who had done most in the development of continuous-current apparatus in 1893 were generally ready to admit could not be solved by continuous-current methods.

The wisdom of the decision to reject the three-phase system is at least open to question. The decision was reached by the directors of the Cataract Construction Company in May, 1893. I am on record prior to that time, and, in fact, as far back as 1889, in advising the use of the two-phase system, but from present knowledge I believe that the decision to reject the three-phase system in May, 1893, was a mistake. At that time Charles F. Scott's clever invention of the method of winding and connecting transformers to secure three-phase currents from a two-phase source had not been announced and but for that invention it is my opinion that the additional cost of conductors required by the two-phase system would to-day turn the scale in favor of the three-phase plan. Under the conditions existing at Niagara, however, where single-phase power is required in a number of cases, the two-phase arrangement possesses a substantial advantage in the entire separation of phases and the convenient balancing of the load, and were a new Niagara problem to be presented to-day with conditions precisely such as are met by the existing plant, as we now have the means of obtaining three-phase currents for the more distant and, therefore, more expensive transmission, while using for local distribution either single-phase or two-phase circuits, I should still incline to the use of two-phase alternators.

The American Street Railway Association.

The Annual Convention This Week at Madison Square Garden, New York, Very Largely Attended—The West Strongly Represented—Opening Proceedings—A Fine Programme—Vast Array of Interesting Exhibits.

THE convention of the American Street Railway Association, which is being held at the Madison Square Garden, in New York city, during the present week, is an occasion of unusual interest and importance. There are represented at it men controlling the traction interests of cities all over the United States and Canada, and representing the directing forces of one of the largest industries which has followed the astonishing development of electrical engineering in the last two decades. One of the things that is noticeable at these meetings is the comparative youth of the men who control this great industry, these men exhibiting in their own persons a sort of index of the youth of the art of electric railroading itself.

It was only fourteen years ago when the first overhead trolley cars to be put into serious and active competition with horse cars climbed the steep hills and rounded the sharp curves of the old Richmond road. As we look back to-day upon that extraordinary experiment in electrical utilization, it is possible to understand fully the courage and foresight of the engineers and officers who promoted it and built it in the face of seemingly impossible obstacles. Its success, which was immediate, marked the establishment of a new and important direction in general engineering and municipal progress, and its organizers builded better than they knew. The great industry of to-day attests the wisdom of their plans.

While every city presented a certain amount of demand for transit, still the creation of transit facilities so stimulated this demand as to cause entirely new municipal conditions to arise. While the great business interests that have been built about municipal traction service plants have owed their existence to the cities themselves, and the desire of their inhabitants to move quickly and cheaply from place to place, still no single public service development in the last half-century has so reflected upon the municipality itself as has the trolley railroad. Much of the movement from centres of population outward into the suburbs, which distinguishes the present time, is due to the perfection of the electric railway, and it is certain that the change in the face of cities which is now going on has been suggested and accelerated by the extension of these lines of communication.

Probably, therefore, the men who compose the American Street Railway Association have done more to better and make pleasanter the conditions of the inhabitants of cities than any other men who have worked during the same space of time. Their service is one that has not been unprofitable to them, but which should nevertheless be recognized by their contemporaries at the full value of its extraordinary benefit and magnitude.

A valuable feature of the convention, which marks the gathering this year, is a superb exhibition of electric street railway apparatus and appliances held in the great hall of the Madison Square Garden, a full list appearing on another page. It is expected that more detailed descriptions of individual exhibits will be given in succeeding issues.

The great space of the Madison Square Garden is completely filled by the exhibits, and it has been found necessary to erect a gallery around three sides of the large main hall and also to devote the annex, forming the southwestern corner of the building, to exhibition purposes. Among the many striking exhibits, perhaps the most spectacular is that made by the Westinghouse companies in the middle of the main floor. Here, in addition to an exhibit of a large variety of electric traction machinery, a grade over one hundred feet long has been built, using standard track, and on this is mounted a heavy double-truck car, equipped with the Standard Traction Brake Company's electric track brakes. Exhibitions are given of this, showing how the car may be stopped almost instantly when descending the grade at high speed. An interesting feature of this brake mechanism is that the resistances used in connection with it are mounted under the car seats and serve to heat the car in winter.

Flanking this exhibit is found on one side the display made by the Crocker-Wheeler Electric Company, which includes a large engine-type, direct-current street railway generator, and the exhibit of Sprague multiple-control system apparatus. This is one of the most elaborate and handsome exhibits in the building. A complete train line is shown, with the motor equipment of four cars and all of the details of the motor-driven controllers and reversers and train-line apparatus are so arranged as to be shown in full operation.

On the other side of the building the Pennsylvania Steel Company makes a handsome exhibit of switches, frogs, special work and sections of rails.

On the main floor, facing the main entrance, is a large space devoted to the General Electric Company. Here are shown an almost bewildering variety of street railway apparatus and also of apparatus for handling the high-tension polyphase currents now so widely used in the generating plants of large street railway companies. Among other exhibits in this section may be noted the high-tension oil-break, motor-controlled switch, designed for the Metropolitan Traction Company, of New York.

The Christensen Engineering Company, of Milwaukee, Wis., exhibits a fine display of its air-brake apparatus, including its motor compressors, handling apparatus, etc.

At the rear of the main floor is a very handsome exhibit of trucks made by the J. G. Brill Company, of Philadelphia, and near this is shown one of the superb new cars which are being introduced on the system of the Brooklyn Heights Railway Company. This car seats thirty-six passengers, in seats of a peculiar design, giving each passenger an individual seat and yet so economizing space as to leave a large standing room and broad aisle for the rush hours. The car is a fine example of modern construction and shows how far progress in this direction has moved for the suppression of dust-gathering and dirt-collecting ornaments such as were formerly in vogue.

Some of the most interesting exhibits in the building are found in the gallery, which is devoted to the lighter variety of electric railway equipment. Among the most interesting of these exhibits is that of the Morris Electric Company, of New York, situated in the large space at the east end of the south gallery. This ex-

hibit includes, in addition to a number of well-known specialties, a very fine display of steel poles and overhead construction apparatus, and some interesting new arc headlights and electric track switches.

In the opposite gallery is erected a handsome exhibit of the Mayer & Englund Company, showing railway specialties. Near the stairs at the west end of the building is the exhibit of the Pittsburgh Reduction Company, showing aluminum in all its forms, from rough ingots to manufactured cables.

In the annex are a number of very elaborate smaller exhibits, these being confined, for the most part, to parts and specialties. Among them may be mentioned a fine display of valves and fittings made by the Crane Company, and of boiler compounds and chemicals made by the Dearborn Drug and Chemical Company. Taken as a whole, the exhibition, which has been hastily assembled, reflects the greatest credit upon the electrical supply companies and the individuals who have undertaken it. Much credit is also due to the indefatigable efforts of Mr. Marcus Nathan, the superintendent of exhibits.

WEDNESDAY, OCTOBER 9.

The meeting was called to order by President Walton H. Holmes, of Kansas City, who introduced President Randolph Guggenheimer, of the New York Municipal Council.

Mr. Guggenheimer referred to the history of street traction in New York city and highly complimented the Metropolitan Street Railway Company and its president, Mr. H. H. Vreeland. "New York," he said, "has the most reasonable and satisfactory street railway system in the United States." He welcomed the association to the city in cordial terms, and at the conclusion of his address was warmly applauded.

Colonel N. H. Heft moved a recess until twelve o'clock. Mr. John I Beggs, of Milwaukee, strongly opposed the motion, which was withdrawn, and the regular order of business was resumed.

President Holmes then delivered his address. He said:

"In acknowledging the kindly spirit of hospitality pervading the address of welcome to which we have just listened, I but feebly voice the feeling of every member of the association when I say that not the slightest doubt was ever entertained that our meeting in this great metropolis of America would prove to be the most enjoyable and profitable in its history. Personally, I have the highest pleasure in meeting with you on this auspicious occasion, and I extend to one and all my hearty congratulations that once more we are gathered together in convention under circumstances and environment which guarantee that the best interests of the association will be promoted.

"Since the last meeting of this association the President of these United States has been taken away by the ruthless hand of an assassin. Great as was the loss of his taking off, it was not without some compensating advantages. It has served to arouse and unite the whole civilized world in one common bond of sympathy, and to teach us, as well as anarchy, that the foundations of our government, being laid deep and lasting in the principles of liberty, right and justice, are not to be even momentarily shaken by an assault on the Chief Magistrate, however successful. By this untoward event business was nowhere seriously disturbed except by its voluntary cessation for a short period actuated by universal patriotism and sincere grief that a great and good man had been so cruelly and causelessly removed from the service of the country which he had served so faithfully and so well. Peace to his ashes. And may the red hand of anarchy never be seen in our midst again.

"At a session of the executive committee held in the early spring your president appointed a committee on standardizing of street railway equipment, known as the Standardizing Committee. This committee, I am informed, has given the subject very careful thought and consideration, and at the proper time the result of their deliberations will be reported to you. In my judgment no more important subject, looking to permanent improvement in street railway conditions, could engage your attention, and when the report comes in I trust it will receive the full measure of discussion which the question deserves. While the views reported will be of great value in themselves, they will stand out in still bolder relief in the light of a full and intelligent discussion. I am so impressed with the importance of this problem that I beg to suggest the propriety of its continued study and investigation through committee until substantial results are obtained.

"The past year has been one of peace and prosperity in the street railway business. No serious labor troubles have occurred, no doubt due to the fact that a better understanding is constantly being brought about between employer and the employed. Managers and men are everywhere being brought close together, with the result that misunderstandings, often due to unauthorized acts of subordinates, are of much less frequent occurrence. Imaginary grievances are often more serious than real ones, and generally more difficult of settlement.

"The standard of construction and equipment continues to grow more and more substantial and expensive, contributing measurably to the comfort of street railway patrons. The electric street car of to-day is a palace on wheels compared with the horse coach of twenty-five years ago. The highest degree of comfort is being rapidly attained, and every day gives evidence that the well-equipped street railway has passed beyond the stage of a mere necessity of convenience and is looked upon by a very large percentage of the community as a primary source of pleasure and enjoyment. The street railway manager is nothing more nor less than a merchant selling rides on a large scale. The profit on each ride is so small that money is to be made only by doing a large business. This fact every competent manager fully realizes, and hence it is that he is ever willing to introduce improvements everywhere, even to the extent of discarding substantial and valuable equipment, whenever it can be seen that such action will bring anything like an adequate return in the way of increased patronage. His unremitting endeavor is to induce people to patronize the cars and to that end is constantly providing for them attractions in the way of parks and amusements in great variety. Wherever public parks or places of amusement are to be found, the efforts of the authorities in that direction are supplemented by the street railway manager who supplies them with attractions and exhibitions which would otherwise be wanting.

"The time to be occupied by the deliberations of this association has this year been limited to three days, the whole of Thursday, according to the programme made by the executive committee, being set apart for the consideration of exhibits made by the supply men. The action of the executive committee in thus emphasizing the importance of these exhibits I have no doubt will meet with your hearty approval. They contain all that is new and valuable to be known in the machinery and appliances pertaining to the business in which we are engaged. A careful and discriminating study of them is almost an education in itself. They have been brought from everywhere, in many instances from great distances at large expense, and are displayed in a manner most attractive and instructive. It is but right that this substantial recognition should be made of this exceedingly valuable feature of these conventions.

"I trust that the members of this association will take particular interest in the work of the Accountants' Association, which is assembled here in convention at this time. They are accomplishing much of value in their special department, and by the work they are doing are greatly facilitating the interchange of desirable information and promoting the safe and economical administration of the affairs of street railway companies.

"It gives me great pleasure to be able to state that the present condition of this association is the most healthy and prosperous in its history. During the past year its membership has greatly increased and its bank account is in a most satisfactory condition. No more convincing testimony could be given of the usefulness of the association and of the reason for its existence.

"The thanks of the association are due to the secretary and the executive committee for the able and successful manner in which they have conducted its affairs during the past year.

"In closing, permit me to say that the honor which you have conferred upon me is most highly appreciated. To be the president of this association is an honor of which any man might well be proud, and I shall ever esteem the compliment paid me in my selection to preside over your deliberations as the brightest jewel in the crown of whatever success I may have achieved as a street railway man. If my administration of the high office has been a success it has been due more to the kind and considerate support and cooperation of others than to any merit of my own. I can bespeak for my successor no greater security of success than to be accorded the same generous treatment."

The report of the executive committee was then presented by Secretary Penington and was accepted.

The report of the secretary and treasurer was then read, showing that a number of new members had been recently admitted. A total of membership of 179 companies was shown. Cash in bank amounts to more than $10,000. The report was accepted and congratulations formally extended to the secretary.

Mr. H. H. Vreeland then presented the report of the committee on memorials of deceased members. This consisted of notices of the careers of Messrs. James Affleck, John H. Bowker, Robert P. Brown, David C. Golden, George H. Holt, Albert L. Johnson, Thomas H. McLean, Christopher L. Magee, W. W. Marsh and Martin H. Watts. The report was adopted and made a part of the minutes of the meeting.

The secretary then read a number of invitations.

Mr. Robert McCulloch's paper, entitled "Street Railways; a Review of the Past and a Forecast of the Future," was then presented, in the absence of the author, by the secretary. Mr. McCulloch's paper will appear in a later issue of the ELECTRICAL REVIEW. It was announced by President Holmes that this paper, as well as those by Mr. G. W. Baumhoff, St. Louis, entitled "The American Street Railway Association; the Purposes of Its Organization and the Benefits Accruing to Investors and Operators of Street Railway Properties by Membership Therein," and by Mr. C. S. Sargeant, of Boston, on "The Public, the Operator and the Company," would not be read, as they had been printed in advance.

The paper by Mr. Ira A. McCormack, of Cleveland, Ohio, entitled "Relations of Interurban and City Railways," was then taken up. Mr. McCormack gave a brief résumé of the paper. He spoke of the difficulty in getting information from general managers about traffic agreements. Western cities are more given to the making of such agreements than those in the East. The paper dealt with details of the management of foreign cars, or those of interurban lines, on city roads. It was a strong argument for the encouragement of interurban lines by the managements of city systems.

Mr. A. E. Lang, of Toledo, opened the discussion. He said that each city presented its own peculiar conditions which were different in each case. He confined himself in his remarks to contracts and arrangements existing in Ohio. In some of these cities the city company expected to make the interurban cars do city work. In Toledo, however, a different arrangement is in vogue, the employés of the suburban company running the cars while in the city. This would not be a good plan unless some system of control over the suburban company's employés can be put into effect. This arrangement he had been able to enforce. He spoke of arrangements for dividing receipts from both passengers and freight. The Supreme Court of Ohio has held recently that interurban companies can bring freight into cities irrespective of municipal ordinances. In Toledo a freight depot has been built in the centre of the city. A charge to the interurban companies for rental of this terminal property is made. Some

difficulty is experienced with the wheels used on suburban cars, having a broader tread and deeper flange than those used in the town. Mr. Lang cited an instance of this. No transfer arrangements have been made for passengers, but the increase of business due to people brought in has, however, been felt. Concessions are generally necessary to help the suburban lines get started, but it pays to make them. As to freight, the lines in the neighborhood of Toledo use special freight cars which are brought in at times which are convenient. This traffic was welcomed by many dealers. Mr. Lang told of dealers in produce, etc., who had told him of these advantages. In the future the interurban roads would be very valuable on account of their freight-carrying features.

Mr. O. T. Crosby spoke of the probability of changed conditions in the future. The tendency is to a divergence in equipment and between the mechanical and electrical operation of city and outside lines. City roads have become standard, while the country road has not reached the limit either of size of cars or of speed. Our interurban service must approximate more and more to steam railway practice, and we must not forget the experience that has been accumulated by main line engineers for half a century. He thought that it was almost necessary to put down a special track to accommodate the large, heavy and fast cars of the interurban lines.

Mr. Willis E. Gray agreed with Mr. Crosby. Many problems to be solved will require a change in mechanical equipment. He spoke of the importance of increased speed and freight facilities, and said that recognition by the steam roads as serious competitors must soon follow.

Mr. L. E. Meyers spoke of freight switching and transfers with important railway systems, at Peoria, Ill. He described the conditions of this service, and stated that a complete train despatching system had been found necessary. He thought that the only recognition that could be had from the steam roads was such as could be forced. An independent entrance to a town is the solution of the interurban-city dispute, for the city business equitably belongs to the city road.

Mr. T. J. Nicholl, of Rochester, N. Y., said the question depended somewhat upon whether the suburban line ran on the highway or on a private right of way. A T rail is practically necessary for high-speed suburban lines, and cars built for this do not operate well on grooved city rails. He described conditions in Rochester which had caused much trouble in the design of suburban lines. To get business on suburban lines high speed is necessary, and if his company had to build again it would have a private right of way. Freight cars to be run in a city should resemble passenger cars in finish, so as to avoid criticism by citizens.

Wednesday afternoon was devoted to further discussion of Mr. McCormack's paper and was followed by Eugene Chamberlin on "Best Form of Car for City Service," and by M. F. Hopkins on "Alternating and Direct-Current Transmission in City Lines," both being discussed at length. The association adjourned until Friday forenoon to give the street railway men opportunity to inspect the exhibits Thursday.

CONVENTION NOTES.

A concert by Kaltenborn's orchestra was given for the benefit of the visiting ladies at the Murray Hill Hotel Wednesday, and luncheon was served.

An automobile ride and luncheon at the Claremont were the programme for the ladies on Friday. This ride was tendered by President Henry Sanderson, of the New York and Electric Vehicle Transportation Company.

The annual banquet occurs at Sherry's Friday evening.

On Saturday, through the kindness of the Bethlehem Steel Company, a special train takes the members of the association to South Bethlehem, Pa., to visit the great works of the company. Luncheon will be served at 1 P. M. at South Bethlehem.

The entire day Thursday was devoted to inspecting the unusually fine exhibit of the manufacturers and supply houses in the large central hall of Madison Square Garden.

Association badges were honored for passage on surface street car lines and elevated roads of New York and Brooklyn.

The American Telephone and Telegraph Company tendered the free use of its long-distance lines from the Garden before 9 A. M. and after 6 P. M. The New York Telephone Company gave free service to the New York exhibitors at the Garden. The Edison company supplied free current to exhibitors.

THE ATTENDANCE.

Among the early registrations of street railway men at the Murray Hill Hotel were the following:

D. B. Dyer, president, and R. R. Conklin, vice-president Augusta Railway Co., Augusta, Ga.; J. B. McClary, general manager Birmingham Railway, Light and Power Co., Birmingham, Ala.; John H. Graham, second vice-president Brockton Street Railway Co., Brockton, Mass.; John A. Rigg, president, F. L. Fuller, general manager, H. C. Moore, vice-president, and A. G. Jack, superintendent Chester Traction Co., Chester, Pa.; T. C. Penington, secretary of the association and treasurer Chicago City Railway Co.; Ira A. McCormack, general manager Cleveland Electric Railway Co.; N. H. Heft, president Meriden Electric Railroad Co., Meriden, Ct.; M. S. Hopkins, general superintendent Columbus Railway Co., Columbus, Ohio; Walton H. Holmes, president Metropolitan Street Railway Co., Kansas City, Mo.; E. P. Shaw, Jr., general manager Haverhill & Amesbury Street Railway Co., Haverhill, Mass.; H. H. Vreeland, president Metropolitan Street Railway Co., New York; J. R. Beetem, general manager New York & Queens County Railway Co., Long Island City, N. Y.; L. E. Myers, general manager, I. C. Pinkney, general counsel, and Walter Barker, director Peoria & Pekin Terminal Railway Co., Peoria, Ill.; W. Worth Bean, president St. Joseph & Benton Harbor Electric Railway Co., St. Joseph, Mich.

Among the manufacturers present:

Burton R. Stare, general superintendent Peckham Manufacturing Co., Kingston, N. Y.; P. M. Boyd, secretary, and H. D. Bayne, agent of the motor department Lorain Steel Co., Lorain, Ohio; and Major H. C. Evans, of New York, representing the same company; Lieutenant Frank W. Toppan, of New York, representing the Bay State Traction Co.; Henry L. Shippy, of John A. Roebling's Sons Co., of New York, and George C. Bailey, of the same company, Chicago; Captain W. L. Candee, H. Durant Cheever and George T. Manson, of the Okonite Co., of New York; A. A. Thresher, of the Thresher Electric Co., Dayton, Ohio; Henry A. Reed, of the Bishop Gutta-Percha Co., New York; Dr. W. M. Habirshaw, of the India Rubber and Gutta-Percha Insulating Co., of Yonkers, N. Y.; Charles E. Dustin, of the Charles E. Dustin Co., of New York; Frank MacGovern, of Rossiter, MacGovern & Co., New York; Lieutenant Frank J. Sprague and H. M. Davis, of the Sprague Electric Co., New York; Martin J. Insull, of the General Incandescent Arc Light Co., of New York; J. F. Stevens, of the Keystone Electrical Instrument Co., of Philadelphia; J. H. Carson, J. A. Stowe and C. S. Ackley, of the Sterling-Meaker Co., New York; F. G. Bolles, of the Bullock Electric Manufacturing Co., Cincinnati; E. H. Abadie, Wagner Electric Manufacturing Co., St. Louis; J. H. Meek, of the H. W. Johns Manufacturing Co., New York; Elmer P. Morris, of the Morris Electric Co., New York; John A. Brill and W. H. Heulings, Jr., of the J. G. Brill Co., Philadelphia, Pa.; J. R. Ellicott, Standard Air Brake Co., New York; Jabez Gilbert, Merritt Electric Air Brake Co., New York; G. W. Hart, Union Stop Signal Co., Fall River, Mass.; J. V. Caldwell, American Stoker Co., New York; Herbert Lloyd and J. R. Williams, Electric Storage Battery Co., Philadelphia, Pa., and Albert Taylor, New York; E. S. Garden, Bay State Car Heating Co., of Massachusetts; W. W. Donaldson, Gould Storage Battery Co., New York; Wiley Brown, Bridgeport Brass Co., New York.

Exhibitors at the Convention.

This season the exhibitors at the convention comprise practically the whole range of the electrical manufacturers who have to do with articles useful upon electric railways; a full list follows:

American Telegraphone Co., 20 Broad street, New York.

American Vitrified Conduit Co., 39 Cortlandt street, New York.

Atlas Railway Supply Co., Manhattan Building, Chicago, Ill.

American Railway Supply Co., 24 Park Place, New York.

Anderson, A. & J. M., Boston, Mass.

American Brake Shoe Co., Chicago.

Allston Foundry Co., Boston, Mass.

Adams & Westlake Co., 26 Cortlandt street, New York.

American Car Seat Co., 18 Guernsey street, Brooklyn, N. Y.

American Electric Heating Corporation, Boston, Mass.

American Electrical Switch Co., Pittsburgh, Pa.
American Circular Loom Co., Chelsea, Mass.
Bierbaum-Merrick Metal Co., Buffalo, N. Y.
Baltimore Car Wheel Co., Baltimore, Md.
Bridgeport Brass Co., 19 Murray street, New York.
Brill Co., J. G., Philadelphia, Pa.
Bay State Electric Heat and Light Co., 286 Roxbury street, Boston, Mass.
Brandau, G. F., 18 Thorn street, Utica, N. Y.
Brown, Harold P., 120 Liberty street, New York.
Bishop Gutta-Percha Co., 420 East Twenty-fifth street, New York.
Brady Brass Co., 202 Tenth street, Jersey City, N. J.
Brooklyn Heights Railroad Co., Brooklyn, N. Y.
Bliss Manufacturing Co., R., Pawtucket, R. I.
Crocker-Wheeler Co., Ampere, N. J.
Chapman Double Ball-Bearing Co., The, 49 Wall street, New York.
Christensen Engineering Co., 135 Broadway, New York.
Consolidated Car Heating Co., 413 North Pearl street, Albany, N. Y.
Consolidated Car Fender Co., 39 Cortlandt street, New York.
Camp Co., H. B., Akron, Ohio.
Continuous Rail Joint Co. of America, Newark, N. J.
Creaghead Engineering Co., Cincinnati, Ohio.
Curtain Supply Co., 85 Ohio street, Chicago, Ill.
Crane Co., 490 Cherry street, New York.
Columbia Machine Works, 18 Fulton street, Brooklyn, N. Y.
Corning Brake Shoe Co., Corning, N. Y.
Diamond State Steel Co., Wilmington, Del.
Dearborn Drug and Chemical Works, 27 Rialto, Chicago, Ill.
Dewitt Sand Box Co., Troy, N. Y.
Dallett & Co., 201 Walnut Place, Philadelphia, Pa.
Duff Manufacturing Co., Pittsburgh, Pa.
Electric Railway Equipment Co., Cincinnati, Ohio.
Electrical Review Publishing Co., 13 Park Row, New York.
Electric Storage Battery Co., 100 Broadway, New York.
Franklin Incandescent Lamp Co., Hartford, Ct.
Fowler & Robert Manufacturing Co., 149 Broadway, New York.
Globe Ticket Co., Philadelphia, Pa.
Granger, Francis, 26 Cortlandt street, New York.
Granger Safety Tread Co., 26 Cortlandt street, New York.
General Electric Co., 44 Broad street, New York.
Gold Street Car Heating Co., Frankfort and Cliff streets, New York.
Gould Storage Battery Co., 25 West Thirty-third street, New York.
Globe Electric Manufacturing Co., Cleveland, Ohio.
Heywood Brothers & Wakefield Co., 129 Charleton street, New York.
Hale & Kilburn Manufacturing Co., 8 East Fourteenth street, New York.
Ham Sand Box Co., Troy, N. Y.
Hipwood-Barrett Car and Vehicle Fender Co., Lakeport, N. H.
Hunter Electric Illuminated Car Sign Co., Cincinnati, Ohio.
International Register Co., 124 West Jackson Boulevard, Chicago, Ill.
Johns Manufacturing Co., H. W., 100 William street, New York.
Knell Air Brake Co., Battle Creek, Mich.
Kinnear Manufacturing Co., Columbus, Ohio.
Keystone Electrical Instrument Co., Philadelphia, Pa.

Mr. Marcus Nathan, Director of Exhibits.

Koppell, Arthur, 66 and 68 Broad street, New York.
Lorain Steel Co., 21 State street, New York.
Lehigh Car Wheel and Axle Works, Catasauqua, Pa.
McGuire Manufacturing Co., Chicago, Ill.
Magann Air Brake Co., Limited, G. P., Fourth street, Detroit, Mich.
McCardell & Co., J. R., 27 North Warren street, Trenton, N. J.
Morris Electric Co., 15 Cortlandt street, New York.
Mayer & Englund Co., 85 Liberty street, New York.
McLaughlin Car Coupler Co., Hutchinson street, Philadelphia, Pa.
Macallen Co., W. T. T., Boston, Mass.
Merritt Air Brake Co., 253 Broadway, New York.
Monarch Fire Appliance Co., 27 William street, New York.
Metal Sales Co., Cleveland, Ohio.
Nuttall Co., R. D., Garrison alley, Pittsburgh, Pa.
National Carbon Co., Cleveland, Ohio.
National Lock Washer Co., 65 Johnson street, Newark, N. J.
Newcomb, F. H., 136 Flatbush avenue, Brooklyn, N. Y.
New Haven Car Register Co., New Haven, Ct.
National Lead Co., 100 William street, New York.
Ohio Brass Co., Mansfield, Ohio.
Ohmer Car Register Co., Dayton, Ohio.
Peckham Manufacturing Co., 26 Cortlandt street, New York.
Pennsylvania Steel Co., Steelton, Pa.
Pittsburgh Reduction Co., 99 John street, New York.
Partridge Carbon Works, Sandusky, Ohio.
Pfeffer, Herman, 13 Park Row, New York.
Pantasote Co., 29 Broadway, New York.
Pearson Jack Co., 64 Federal street, Boston, Mass.
Paige Iron Works, Monadnock Block, Chicago, Ill.
Protected Rail Bond Co., Philadelphia, Pa.
Ramapo Iron Works, Hillburn, N. Y.
Rochester Car Wheel Works, 556 West Thirty-fourth street, New York.
Ridlon Co., Frank, 200 Summer street, Boston, Mass.
Reliance Manufacturing Co., 56 Wilder street, Brockton, Mass.
Robins Conveying Belt Co., 13 Park Row, New York.
Sherwin-Williams Co., The, Newark, N. J.
Sjoberg & Co., J. P., 145 Eleventh avenue, New York.
Sprague Electric Co., 527-531 West Thirty-fourth street, New York.
Street Railway Journal, 120 Liberty street, New York.
Street Railway Review, Chicago, Ill.
St. Louis Car Co., 8000 North Broadway, St. Louis, Mo.
Standard Paint Co., 100 William street, New York.
Standard Varnish Works, 29 Broadway, New York.
Sterling-Meaker Co., 141 East Twenty-fifth street, New York.
St. Louis Register Co., 57 Broadway, New York.
Speer Carbon Co., St. Marys, Pa.
Sterling Varnish Co., Pittsburgh, Pa.
Stuart-Howland Co., 279 Devonshire street, Boston, Mass.
Streetor Brake Shoe Co., Bloomfield, N. J.
Taylor Electric Truck Co., Troy, N. Y.
Taunton Locomotive Manufacturing Co., Taunton, Mass.
Tramway and Railway World, London, W. C., England.
Union Stop and Signal Co., Fall River, Mass.
United States Steel Co., 145 Oliver street, Boston, Mass.
Universal Safety Tread Co., 45 Broadway, New York.
United States Projectile Co., First avenue and Fifty-third street, Brooklyn, N. Y.
United States Electric Signal Co., Watertown, Mass.
Van Dorn & Dutton Co., Cleveland, Ohio.
Van Dorn Co., W. T., Monadnock Block, Chicago, Ill.
Westinghouse Electric and Manufacturing Co., 120 Broadway, New York.
Wharton & Co., Wm., Jr., Philadelphia, Pa.
Weber Railway Joint Manufacturing Co., 71 Broadway, New York.
Wheel Truing Brake Shoe Co., 106 Miami avenue, Detroit, Mich.

Coal Handling at the Lincoln Power Station of the Boston Elevated Railway.

Coal handling at power stations is a subject that has lately received a large degree of attention, as many small wastes, whose total is considerable, can be prevented by the installation of a proper system. One of the most comprehensive of such systems is that now in use at the fine station of the Boston, Mass., Elevated Railway Company, on Lincoln Wharf, in Boston.

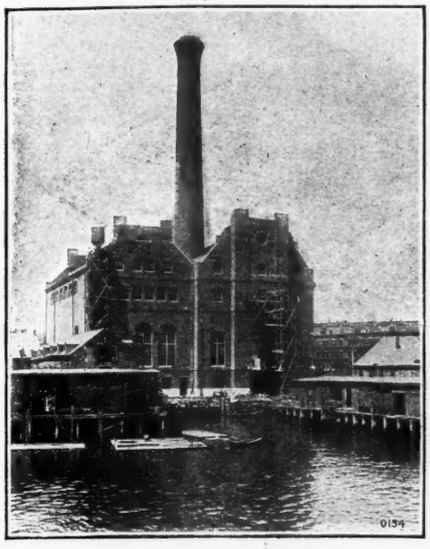


FIG. 1.—THE LINCOLN POWER STATION.

A few details of this station, which was fully described in the ELECTRICAL REVIEW for June 29, 1901, may not be amiss. The building is 155 by 145 feet in area. It is built of brick, with limestone trimmings, and has a tile roof. Although the eastern and western walls are of brick, it is expected that the building will be extended in these directions later. The brick chimney is 251 feet high, with a circular flue 13 feet in diameter.

The pumps, condensers and all piping are placed below the level of the engine-room floor. The boiler room is at an elevation above the ground, and the coal is carried above this in a steel pocket. The capacity of this pocket is 3,000 tons of coal, and room for 5,000 tons more is reserved on the company's wharf, adjacent to the building.

The total nominal horse-power of the boilers is 6,000, there being six batteries, each consisting of two 500-horse-power, water-tube, Babcock & Wilcox boilers. The 12 boilers are equipped with mechanical stokers and fuel economizers.

The engine room will contain three generating units. The two that are already installed each consists of a vertical cross-compound engine, direct-coupled to a generator. The rated capacity of each generator is 2,700 kilowatts.

The continuous operation of the above-mentioned generating machinery depends upon the continuous supply of coal to the boilers. Consequently, the authorities of the Boston Elevated Railway made a thorough investigation to determine the system of coal handling that would, all things considered, best suit the conditions involved. The decision was made to install an equipment of coal-handling machinery manufactured by the C. W. Hunt Company, of West New Brighton, Staten Island, N. Y.

Figs. 2, 3 and 4 show the general arrangement of the conveyor system as already installed in the power-house, together with the proposed equipment for the coal pockets which are to be placed on a dock extension adjoining the power-house.

The equipment of coal-handling machinery in the power-house proper consists of two systems of Hunt standard noiseless gravity bucket conveyors, each about 500 feet long and with a maximum lift of about 100 feet. This equipment and the proposed installation in the coal pockets on the dock extension comprise two complete duplicate conveyor systems, each about 1,300 feet in length.

This conveyor differs from the ordinary chain conveyors in many particulars. While it is usually called a conveyor and classed with this machinery, it is, in fact, a series of cars linked together, each having a body hung on pivots, gravity keeping them in an upright position, no matter whether the track is horizontal, vertical or inclined. (See Figs. 5 and 6.)

The conveyor is carried on wheels fitted with self-closing oil cups and oil reservoir, is electrically driven (see Fig. 7) and is noiseless in operation.

All shafting is ground on dead centres and runs in removable bronze bushings. All gears are machine cut and pressed on taper shafts. Careful provision is made for thorough oiling, and all parts are made to jigs and templets on the interchangeable system.

The bearings, the axles, the links and the buckets are as accurate in workmanship and as durable in use as the corresponding parts of machine tools used in manufacturing establishments.

The motion of the conveyor is obtained by pawls pushing the chain along, as shown in Fig. 8, entirely avoiding the troubles of sprocket wheels. The lengthening of the chain by wear of the links,

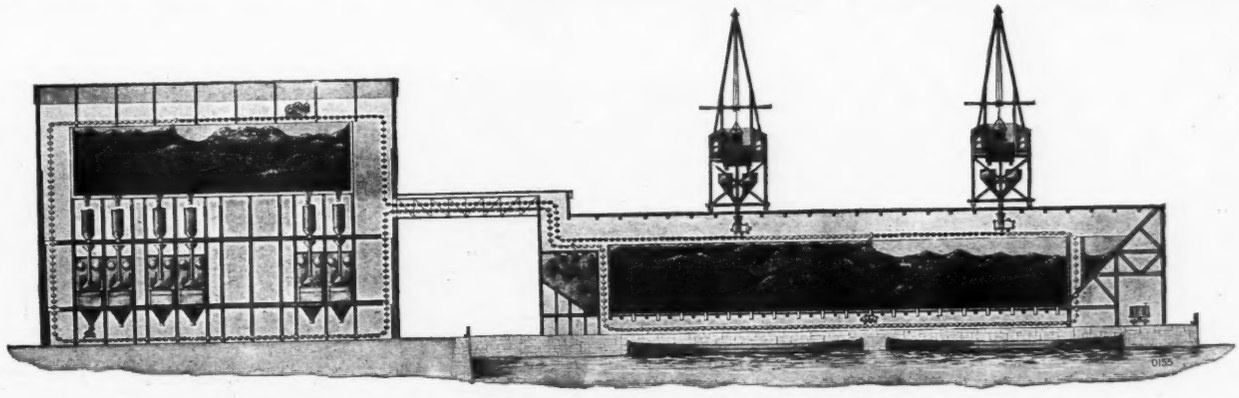


FIG. 2.—LONGITUDINAL SECTIONAL VIEWS OF STATION AND PROPOSED COAL POCKETS ON DOCK EXTENSION, SHOWING LOCATION OF COAL HANDLING MACHINERY.

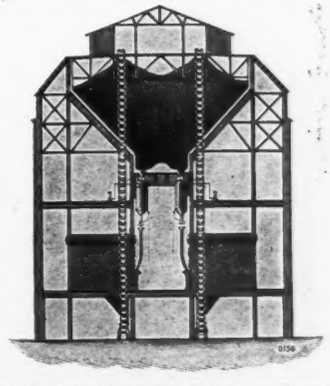


FIG. 3.—END SECTIONAL VIEW OF POWER-HOUSE.

which is a serious matter when sprocket wheels are used, is not noticeable when pawls are employed for driving. The pawls give a steadier motion than sprocket wheels, and permit the power to be applied to any point in the conveyor chain. The wear on the pawls is an insignificant amount, and as all the working bearings are of ample area and can be thoroughly oiled, the conveyor should work the same after years of use as when first started.

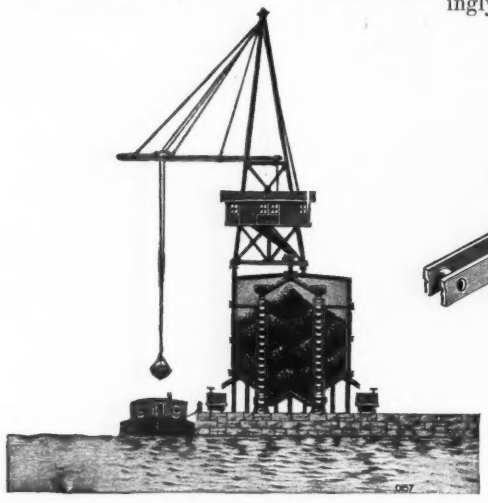


FIG. 4.—END SECTIONAL VIEW OF PROPOSED COAL POCKET ON DOCK EXTENSION.

A rotary filler, shown in Fig. 9, is used on the lower line for feeding the coal and ashes into the conveyor buckets. This filler measures a predetermined amount of material and deposits it in each passing bucket. Fig. 10 shows how evenly the buckets are filled.

The coal pockets shown on the right of the power-house in Fig. 1 are not yet built, but the arrangement indicated in the cut shows the proposed completed plant. Under this arrangement coal will be received from the barges and schooners at the dock, unloaded by means of movable steeple towers, cracked to a suitable size by a coal cracker, and then stored in the coal pockets. From here it will be carried by the conveyor system to the upper part of the power-house and stored, ready to come down through the weighing machines to the boilers below. It should be noted that coal and ashes can be handled simultaneously by the same conveyor. The ashes are carried to a pocket on the wharf.

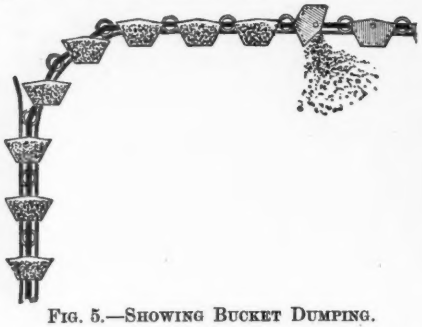


FIG. 5.—SHOWING BUCKET DUMPING.

The Hunt equipment, already installed in the power-house, is remarkable for its convenience and economy of operation. The cost per ton of coal handled, for maintenance, power and attendance, is exceedingly small.

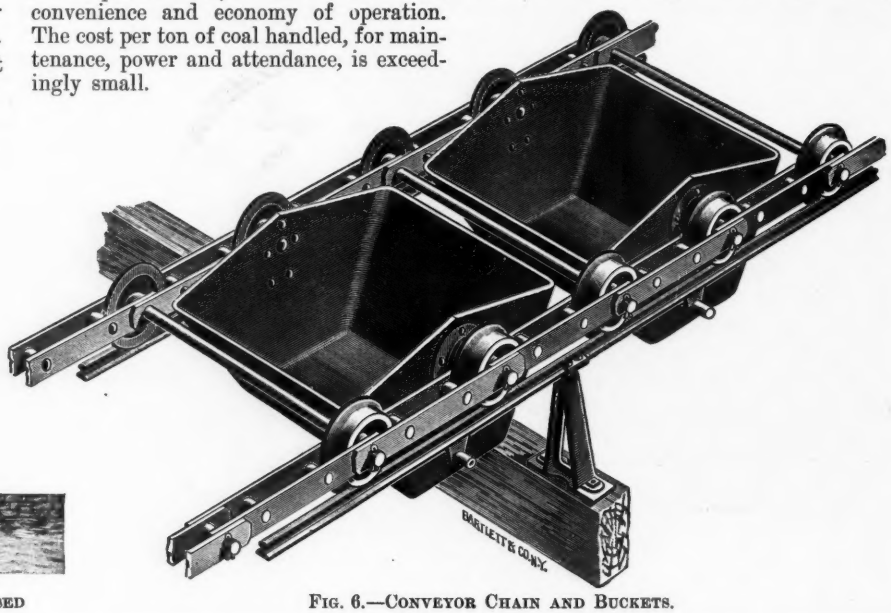


FIG. 6.—CONVEYOR CHAIN AND BUCKETS.

The entire system for handling the coal, from the time of arrival at the wharf until the ashes are removed from the building, is practically automatic and requires the minimum of attention.

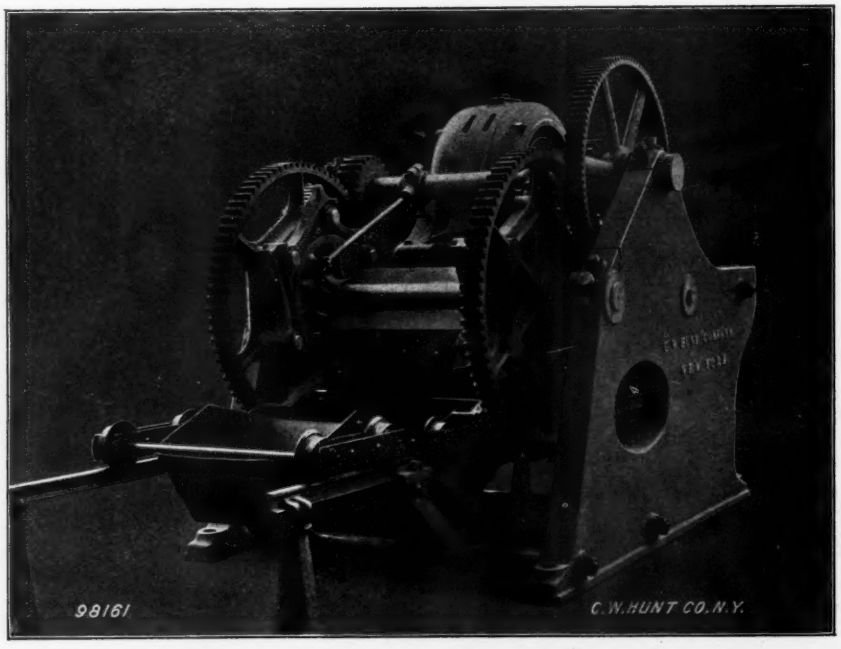


FIG. 7.—ELECTRIC CONVEYOR DRIVER.

Between Halle and Merseburg, Germany, work has been begun on the electric railroad, the construction of which has been authorized by the Prussian Government. Ten miles will be its total length and power will be obtained from the River Salle.

Edison Storage Battery Company.

The Edison Storage Battery Company is pushing work rapidly on its two factories at Glen Ridge and Silver Lake, N. J. Within the next 60 or 90 days it is expected that the company will be in shape to place batteries on the market. The ELECTRICAL REVIEW is informed that the developments respecting this battery are very favorable and the company anticipates a very large business. Mr. Thomas A. Edison is president of the company and Mr. J. F. Randolph, secretary and treasurer, with headquarters at Orange, N. J.

The Sprague Multiple-Unit System.

Near the central portion of the exhibit hall of the Street Railway Convention, at Madison Square Garden, New York, the Sprague Electric Company is showing the working of the multiple-unit system which, since its pioneer development on the South Side Elevated Road, in Chicago, in 1897, by Mr. Sprague, whose similar advance work in the trolley industry is well known, has become widely known as a method of operation and control for handling congested traffic on urban and interurban electric train service.

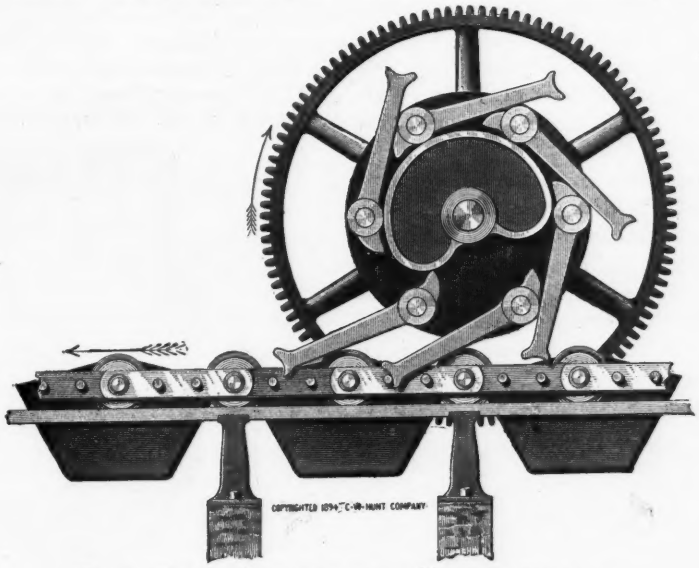


FIG. 8.—DRIVING MECHANISM OF THE NOISELESS CONVEYOR.

The system is a method of train operation and control by which any number of motor cars and any number of cars without motors can be combined into trains at will, and operated from any one of as many points as desired through master switches and a controlling line common to all the cars.

By this method of operation, train lengths and power requirements are varied at will to meet any required schedule and train movement, unnecessary switching and mileage obviated, wear and tear of track and structure lessened, power-house equipment and output reduced, motors protected from overload and the operation of trains reduced to the simplest manipulation.

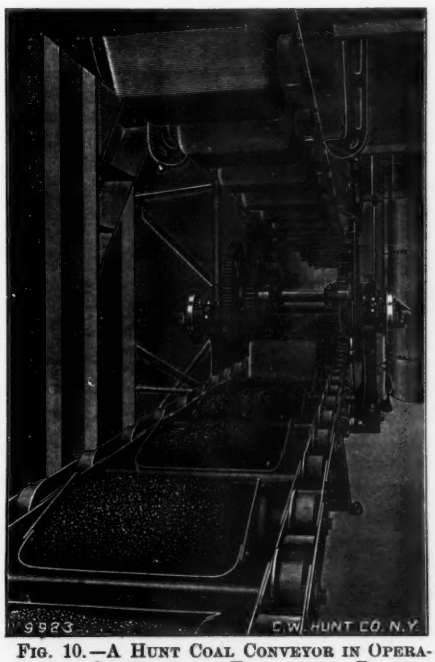


FIG. 10.—A HUNT COAL CONVEYOR IN OPERATION, SHOWING HOW EVENLY THE BUCKETS ARE FILLED.

The system covers the entire range of service from a single car to trains of any length, equipped with any required amount of power.

It is already installed and in regular operation on the Chicago South Side Elevated, the Brooklyn Elevated, the Boston Elevated and the Versailles division of the Western Railway of France. Train lengths vary from two to nine cars, and equipments from 100 to 300 horse-power per motor car.

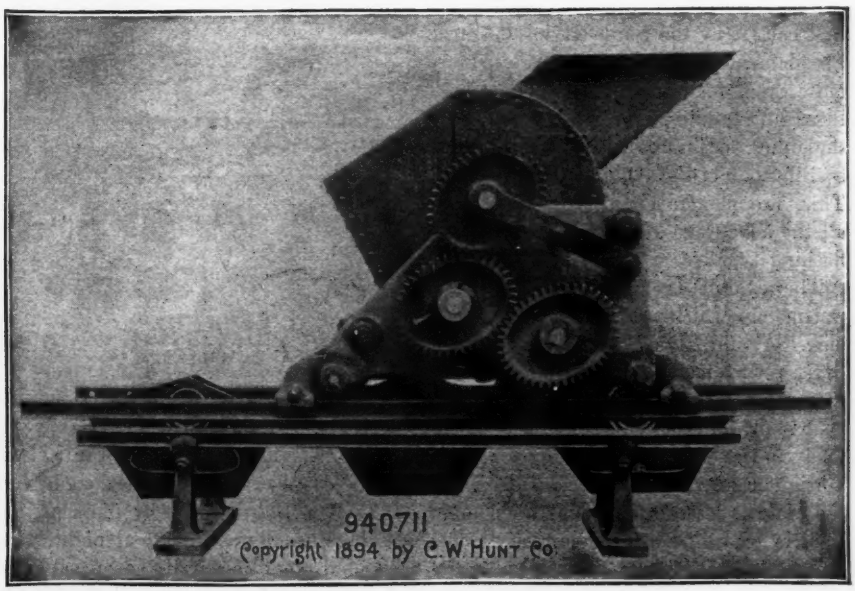


FIG. 9.—ROTARY OR MEASURING FILLER FOR CONVEYOR, ON A SEPARATE TRACK, TO BE MOVED FROM POINT TO POINT AS REQUIRED.

Contract Awarded for Electrical Equipment of the New York Subway.

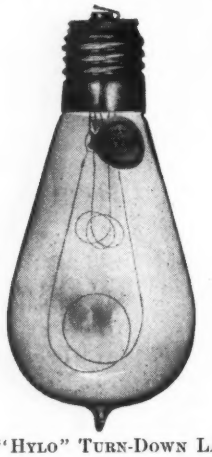
Mr. John B. MacDonald has awarded the contract for the electrical equipment of the main power-house and subway stations of the New York Rapid Transit Railroad to the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa. The value of the contract has not been made public, but it is understood that it will amount to at least $1,500,000. In the contract six 5,000-kilowatt alternators, three 250-kilowatt exciters, twenty-six 1,500-kilowatt rotary converters, seventy-eight 550-kilowatt transformers, and eight motor generating starting sets are called for.

It has been definitely decided that a third-rail system will be adopted as the motor principle for the underground road. The side rail will be used to carry the power and the contact shoe similar to the system to be used by the Manhattan Elevated Railway and which is now in use on the Boston elevated line. To furnish power there is to be one main power-house and eight substations. This power-house will be of brick and will cover an area of 200 by 650 feet. At the present time it is anticipated that two years will be required to complete the building and install the machinery. In the contract it is stipulated that the electrical equipment must be completed by January 1, 1904.

The president of the Rapid Transit Subway Construction Company, Mr. August Belmont, has sailed for Europe. Mr. John B. MacDonald, contractor, Mr. E. P. Bryan, general manager, Mr. S. L. F. Deyo, chief engineer, Mr. L. B. Stillwell, electrical director, and Mr. John Van Vleck, mechanical engineer, also sailed for Europe on Saturday last. The purpose of the party is to visit the underground railways in operation in Glasgow, London, Paris and Budapest and the other systems of electrical transportation in Europe.

An Interesting Contribution to Incandescent Lamp Invention.

Most of the electrical exhibits at the Pan-American Exposition are naturally more interesting to technical people than to the general public. However, there are



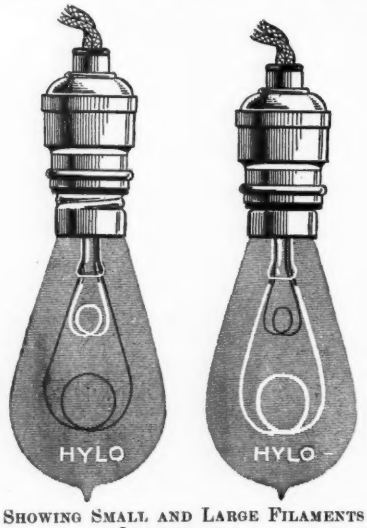
The "Hylo" Turn-Down Lamp.

several things in the electrical building besides phonographs and imitation lightning which interest the layman. One of these is the Hylo lamp. Your eye is first caught by the word "Hylo" outlined in filaments, giving one candle-power, quite easily read. Suddenly, as you look, these low candle-power letters, one after the other, flash up to 16 candle-power, spelling out H-Y-L-O, and then HY-LO. This, the makers claim, is a sign with all the advantage of both continuous and flashing types.

The exhibit is fitted with recording wattmeters which show the lamp's economy. A ruby Hylo for the photographic dark room, made from natural-colored glass and giving the orange-ruby effect, is exhibited. This gives a dim light to load camera and start development and a bright light to finish development when the plate is less sensitive and when more light is needed in order to correctly gauge the work. An illustration and description of this lamp are given. It has two carbon threads, one of the usual size, giving either 8 or 16 candle-power, and a very small "baby" filament giving one candle-power. A quarter revolution of the lamp in its socket turns out the big filament and lights the "baby." The mechanism which accomplishes this comprises merely a flat spring on the lamp base which is pressed against a contact under it by the end-thrust of the lamp. The illustration shows the Edison type, in which the spring is clearly shown.

This lamp does not, strictly speaking, turn down like gas, since there are only two different intensities. The inventor, Mr. W. J. Phelps, has worked out several lamps, in which three and four intensities may be had, but he contends that only two are wanted in the great majority of cases, and that a gas jet is hardly ever to be found burning except in the extreme positions—as high as it will go or as low as you dare to leave it. He says that the regulating sockets, which have been used to some extent, are never run on any intermediate position except for exhibition purposes.

The combined life of the two filaments of this lamp is given as 4,000 hours. The long life of this filament is due to the fact that it is operated at a relatively low temperature. Inasmuch as it gives light enough for the average situation where a turn-down lamp can be used, there is no objection to the low efficiency as measured in terms of watts per candle. The total



Showing Small and Large Filaments Incandescing.

energy required by the Hylo lamp when turned down is only 10 watts.

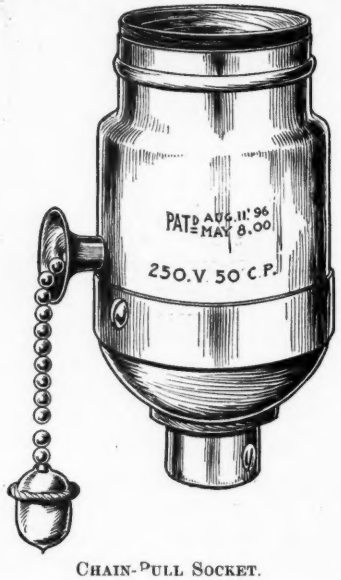
An incidental advantage of this lamp is the fact that extreme variations in voltage do not harm the baby filament, and as these usually occur late at night, when the lamp would naturally be turned down, there is a tendency to protect the big filament from the ill effects of bad regulation.

The makers state that the need for a turndown lamp is not sufficiently understood or appreciated by the central station manager, who usually has too many kinds of work on hand and too much work of each kind. When a consumer changes from gas to electricity he misses the inexpensive low light. The Hylo lamp is intended to banish total darkness. It is manufactured by the Phelps Company, of Detroit. The name "Hylo" is worth noting as an extra good sample of the coined words which have deluged magazine advertising pages of late. "High-Low" tells just what this lamp is and does.

A New Patent Chain-Pull Socket.

A very convenient adjunct to incandescent lamps used for lighting dwellings and public buildings is the Hubbell patent chain-pull socket, manufactured by Mr. Harvey Hubbell, of Bridgeport, Ct. By its use one pull turns on the light and the next extinguishes it. The regular length of the chain is about 10 inches.

This apparatus is said to be more convenient than wall switches and more eco-



Chain-Pull Socket.

nomical, as less wiring is required. It is also approved by the underwriters.

This socket has a very quick make and break. Its contact is large and sliding and the appliance is simple and strong in construction. The chain will stand a strain of 30 pounds without breaking, and without using tools chains of any length may be attached. The cap and shell are held together by a patent lock joint. The length and position of the chain can always be so regulated that every lamp may be within easy reach.

Suit on Booster Patents.

Three bills were filed on October 7 in the United States Circuit Court for the Northern District of Ohio by the Electric Storage Battery Company, of Philadelphia, through its counsel, Mr. John R. Bennett, of New York city, against Sipe & Sigler, the Cleveland Electric Railway Company and the Cleveland & Chagrin Falls Railway Company for infringement of the H. Ward Leonard so-called "booster" patent, owned by the Battery company.

The outcome of these cases will be watched with interest by electric railway owners and builders throughout the United States, as they involve the right to use what is known as the booster system, which is now regarded as convenient in the application of storage batteries to electric railways.

The present suits are against Sipe & Sigler, of Cleveland, the contractors and the railway companies as users of the booster system installed by Sipe & Sigler.

Current Electrical News

COMMERCIAL NEWS

DOMESTIC AND EXPORT

The Electric Railway Company in Winnipeg, Manitoba, is erecting shops at a cost of about $50,000.

It is reported that electric traction in Manila is to succeed horse-power shortly on the street railroads.

The capital stock of the Marvin Electric Drill Company, of Syracuse, N. Y., has been increased from $300,000 to $550,000.

The American Electric Company has been chartered under the laws of the state of New York with a capital of $1,000,000.

The capital of the Lake Shore Electric Company has been increased from $10,000 to $6,000,000. It is said that this company will absorb four lines belonging to the Everett-Moore Syndicate.

At Colorado College the construction of a new science building to cost $300,000 has been begun. Dr. D. K. Pearsons gave $50,000 toward this building, and $100,000 was recently given by an anonymous donor.

The owners of the Temple Street Cable Railway, of Los Angeles, Cal., have decided to adopt electricity for the motive power of the line. A new electric plant will be installed at a cost of $60,000 to $75,000.

It is stated that the Cumberland & Frostburg electric line will not use a trolley system, but a storage system, it is claimed, will be the operating power. The line is expected to be completed by December 1.

The Hudson & Bergen Traction Company has been formally merged into the Jersey City, Hoboken & Paterson Street Railway Company, of Hoboken, N. J., at a meeting of the stockholders of the former company in Hoboken.

Mr. I. A. Sweigard, who was for many years superintendent of the Philadelphia & Reading Railway Company, is said to be at the head of a trolley car system in Pennsylvania, which will soon take in all the principal towns in the Lehigh coal region.

La Sociedad San Francisco has been formed in Madrid with a capital of $250,000, for the purpose of constructing and operating a central electric light station at Villarrobledo, a town of some 10,000 inhabitants, situated within 50 miles of the Spanish capital.

The Metropolitan Street Railway Company, of Kansas City, Mo., has taken out permits for two $40,000 car repair shops to be located at Ninth street and Lister avenue. This is part of the company's project to build extensive machine, repair and paint shops, and eventually its own cars.

Three-phase current is to be used on a comparatively long French line which runs from Grenoble to Uniage, and which is now operated by steam traction. The works situated on the Laffney lakes will furnish the necessary energy at a pressure of about 30,000 volts. If this scheme is successful it is said that other lines of the district will be transformed in the same manner.

The large machines required to equip the Metropolitan electric lighting plant at Wellesden, one of the suburbs of London, will be manufactured by Continental European concerns. The two engines of 6,000 horse-power are to be built by the Swiss engineering firm of Sulzer Brothers, while the same number of 35,000-horse-power generators will be manufactured by Kolben & Company, of Prague, Bohemia.

The Everett-Moore Syndicate has finally reached a definite conclusion as to what it will do with its lines between Detroit and Toledo. There has been some uncertainty till within a short time as to whether the line would be entirely equipped with electricity or part of it used as a steam road. It has been decided, however, to stick to electricity and both lines between the two cities for the whole distance will be electric roads.

News comes that Mr. Charles T. Yerkes has bought another London railroad, or rather has contracted with the Great Northern Railway Company for 999 years to take over its suburban business and the franchise for the projected underground railroad to extend from Holborn to Finsbury Park. Parliament will be asked to grant a franchise for a link less than a mile long to connect this line with Mr. Yerkes's Brompton & Piccadilly line.

A contract has just been awarded by the Mt. Beacon-on-Hudson Association, of Fishkill Landing, N. Y., to the Otis Elevator Company, of Yonkers, N. Y., to construct an inclined railroad up Mt. Beacon on the Fishkill range of mountains. This mountain is over 1,400 feet high. The inclined railroad will be half a mile long and will connect with the trolley road which passes through Fishkill Landing and Matteawan. The contract calls for the completion of the new railroad within four months. Electric power will be used and the plant will be installed as soon as possible.

The final details of the Atlanta Street Railway deal, in Atlanta, Ga., have been arranged at the office of the Mercantile Trust and Deposit Company, of Baltimore, Md. Mr. Joel Hurt, president of the Trust Company, of Georgia, and Colonel Robert J. Lowery, both of Atlanta, Ga., with Gordon Abbott, president of the Old Colony Trust Company, of Boston, and officials of the Mercantile Trust and Deposit Company have arranged the chief details. The deal involves about $1,100,000 in cash and provides for the transfer of the interests of Mr. Hurt and his associates in the Atlanta Railway and Power Company to a syndicate represented by the Mercantile Trust and Deposit Company, of Baltimore, the Old Colony Trust Company, of Boston, and the New York Security and Trust Company, of New York.

It is said that Mr. M. J. Mandelbaum & Company and the Pomeroy-Mandelbaum Syndicate, of Cleveland, Ohio, companies interested in a vast system of interurban electric railways in Ohio, have paid a visit to Mineola, L. I., and completed arrangements for the purchase of the Mineola, Hempstead & Freeport Traction Company's electric railway now in course of construction. The Cleveland Construction Company, in which William Christy, a prominent member of the Pomeroy-Mandelbaum Syndicate, is interested, is building the Mineola, Hempstead & Freeport Railroad. This company has recently awarded contracts for the installation of a storage battery plant and two 200-kilowatt rotary transformers, power to operate the road being furnished by the Roslyn Light and Power Company.

ELECTRIC RAILWAYS

A survey for the electric line between Findlay, Ohio, and Lima has been begun.

The first rails have been laid on the new trolley line between Altoona, Pa., and Tyrone.

The council of Warren, Ohio, has granted an extension for 25 years of the franchise of the Trumbull Electric Railroad Company.

The Syracuse, Lakeside & Baldwinsville Railway Company is an applicant for franchises for street railways in Syracuse, N. Y.

The franchise of the Chicago & Detroit Electric Railway Company has been extended six months by the council of Marshall, Mich.

The Arlington Electric Line, of Arlington, Ohio, has been completed and cars are running regularly.

Construction work on the Cumberland, Eckhart & Frostburg Railway is rapidly nearing Cumberland, Md.

Mr. James K. Brown, of Lorain, Ohio, is interested in a new electric railway from Port Clinton to Toledo.

Good progress is being made in the work of constructing the Concord & Nashua Electric Railway between Concord and Nashua, N. H.

The Boston & Worcester Street Railway Company has secured a franchise to construct a railway through Boylston street, in Newton, Mass.

A franchise has been granted to the Mohawk River Traction Company to build an electric road through certain streets in Sharon Springs, N. Y.

The city of Sycamore, Ill., has granted a franchise for an electric line to connect DeKalb and Sycamore. Mr. E. B. Magill, of Chicago, Ill., is interested in the line.

In Fresno, Cal., the Fresno City Railway Company has been incorporated with an authorized capital stock of $500,000, to construct an electric street railway system 43 miles in length.

Representatives of the East St. Louis & Belleville Electric Car Line System have been investigating the route and terminal facilities for a line between Carbondale, Ill., and Murphysboro.

The Amsterdam Street Railroad Company, of Amsterdam, N. Y., has let the contract for the construction of the extension of the Amsterdam line from Akin to Johnstown to D. A. Crage & Company, of Buffalo.

The street committee of the city council of Richmond, Va., is considering the petition of the Petersburg Electric Line to run into Broad street, and the franchise ordinance of the Jenkins Rapid Transit Company.

The construction work on the Interurban line between Stephen's Point, Wis., and Grand Rapids will be commenced about October 15. The new line will be built and controlled by the Wisconsin Valley Power and Light Company.

Governor John Hill, Mr. J. Manchester Haynes and others are interested in an electric railway from Augusta, Me., to Warren. The road is to be 27 miles long and pass through the towns of Chelsea, Whitefield, Jefferson and Waldoboro.

Judge Roraback, of the Superior Court of

Connecticut, has signed a formal decree giving the Cheshire Trolley Company the privilege of extending its road in two directions, one from Cheshire to Milldale, and another from Cheshire to South Meriden.

Surveyors have gone over the route for a proposed electric road from Rochester to Painted Post in Bath, N. Y. Connections will be made with the Corning & Elmira Electric road, thus affording a direct electric line between Rochester and Elmira.

The Berkshire Electric Street Railway Company, of Pittsfield, Mass., has awarded the contract for the building of its new power station to Dodge & Devanney, of Pittsfield, for about $40,000. The contract includes the foundations for new machinery.

Five petitions and franchises have been submitted to the city council of Savannah, Ga. The petitioners are the Savannah, Thunderbolt & Isle of Hope Railway, the Savannah Transit Company and Mr. D. B. Lester, Mr. J. S. Collins and Mr. E. A. Richards.

Upon the western end of the Providence & Danielson Electric Railroad, which extends from Danielson to Providence, work is being pushed rapidly. About 300 Italians are at work on the road, and the company expects to reach the Connecticut line some time in December.

Work has been commenced upon the power-house of the Cincinnati & Eastern Electric Railroad, which is to be located in the vicinity of Coney Island, Ohio. It is expected that the road will be in operation between Cincinnati and New Richmond, a distance of 20 miles, by the first of January.

The Suburban Street Railway Company is the name of an organization which has just been effected by capitalists and merchants in Independence, Mo. The purpose of the company is to construct an electric railway from Independence to Kansas City. Colonel Joseph Mercer and Mr. John T. Smith are among those interested in the new line.

The plant of the Virginia Electrical Railway and Development Company, of Richmond, Va., will within a few months be one of the largest and most perfect of its kind in the South. The plant of this company is to be greatly extended as rapidly as the work can be done. Work on the plans for the extension of the big power-house on the river is now going on.

Mr. W. J. Connors, proprietor of the Buffalo *Courier* and Buffalo *Inquirer*, and president of the Hamburg Railroad Company, has been in Dunkirk, N. Y., to arrange for extending to Dunkirk the electric railway which is now nearly completed to Angola. Mr. Connors proposes to have an electric road in operation along the shores of Lake Erie from Buffalo to Dunkirk, a distance of 41 miles, early next spring.

Articles of association for the formation of a street railroad company to build a trolley line from Greenfield to Northfield, Mass., have been signed by the parties interested. Mr. E. Herbert Sanderson and Mr. Alonzo Alfred, of Bernardston, Mass., and others, are to act as directors until the company has been legally incorporated. The capital stock is $35,000. It is not likely that work will be begun on the line before next spring.

It is reported that the Elgin, Aurora & Southern Traction Company, of Aurora, Ill., which embraces the Elgin City, Carpentersville & Aurora road, the Aurora & Geneva road and the Aurora, Yorkville & Morris Railroad, has been financed in Cleveland. The entire system embraces 72½ miles, extending from Carpentersville on the north and Yorkville on the south. The company has a capital stock of $2,000,000 and a first mortgage bond issue of $2,000,000.

ELECTRIC LIGHTING

Additional machinery to double its capacity is to be installed by the Shawnee Electric Light Company, in Shawnee, Okla.

A new building for the electric power plant at the salt works in Ithaca, N. Y., will soon be completed and ready to receive the machinery.

The contract for installing an electric lighting system in Grayling, Mich., has been awarded to the M. B. Wheeler Electric Company, of Grand Rapids.

The Chicago Edison Company, of Chicago, Ill., is building a three-story electric power station and apartment building. The improvements will cost about $60,000.

The municipal electric light plant in Columbus, Ohio, which has been overhauled, is now ready for operation, but the lamps have not been placed in position, which will require a little more time.

In Norway, Mich., the contract for installing the electric lighting plant has been let to the Allen Black Company, of St. Paul, which was the successful bidder at $22,200. Work will soon be commenced.

The Electric Lighting Company, of Middleville, Mich., has its dam and power-house half completed at Labarge, which is to furnish lights and power to residences at Middleville, Hastings and Nashville.

The contract for fitting out the electric plant in the factory of the Zeeland Furniture Company, in Zeeland, Mich., has been awarded to the M. B. Wheeler Electric Company. A 10-kilowatt engine is called for in the contract.

The following new directors were elected to fill vacancies, at a special meeting of the New York & Queens Electric Light and Power Company; Julian D. Fairchild, of Brooklyn, N. Y.; James Pyle and Abram M. Hyatt, of New York, N. Y.

The water-power plant in the electric lighting station in Bangor, Me., has shut down. Until the new lighting equipment is ready for use the machinery will be operated by steam power. New water-wheels are to be installed and the capacity of the plant increased.

The report of electrician William Fowden on the building of a city electric light plant in Atlantic City, N. J., claimed that it could be built for about $179,000, and that it would mean an annual saving to the city of $12,000. This will be greatly doubted by practical electric light men.

A new 600-horse-power cross-compound condensing engine is being installed at the works of the Waltham Gas Light Company, in Waltham, Mass., by the Newton Street Railway Company. A 500-volt dynamo is connected with the engine. The company is also putting in a new upright boiler of 125 horse-power.

Mr. John P. Martin, who is interested in the electric light plant and street railway in Tampa, Fla., accompanied by Mr. H. McQuiston, the financial backer, has been there looking after the business in connection with the deal. They have stated that only a short time will intervene before work upon the enterprise will be begun.

At Southampton, L. I., a new electric light company is to be formed, to be known as the Suffolk Light, Heat and Power Company, the capital stock of the company being $25,000. The stock has already been more than $12,000 over subscribed. It is proposed to erect and equip a first-class modern plant and to furnish a service which will be adequate for the needs of the village.

TELEPHONE AND TELEGRAPH

The Alden Telephone Company is extending its line north to Crittenden, N. Y., and east to Fargo.

The Central District Printing and Telegraph Company has received a building permit in Pittsburgh for its new telephone exchange building on Fourth avenue, which is to cost $63,000.

The city council of Dublin, Ga., has granted a franchise to Mr. A. I. Smith, who owns a long-distance telephone line from Dublin to Irwinton and Toomsboro, to operate and construct a local telephone exchange in that city.

The people of Mount Olivet, Ky., are soon to have telephone connection with Carlisle. A company has been organized for the purpose of erecting a line to Plummers Landing, Licking River, and the line is now being built by way of Piqua.

The New York & New Jersey Telephone Company has bought the old mansion in Brooklyn which was formerly the home of the late Mr. Alfred C. Barnes, father of General Barnes. The property has a frontage of 130 feet in Clinton avenue, and runs back 20 feet to Waverly avenue. The telephone company intends to build on the property a modern central station after the style of the station at Willoughby and Jay streets.

A material reduction has been made in the assessment by the tax commissioners under the special franchise act by the decision of Justice Fursman in the contested assessment case of the Hudson River Telephone Company. The company was assessed at $148,530, and by the decision this is reduced to $115,853.40, on which the tax is $2,479.26. The decision directs that upon this payment the tax shall be canceled.

The town of Bath, N. Y., will soon have telephone connections with the outside world through the long-distance service of the Inter-Ocean company, which will give this town a through line into Rochester, and from Rochester connections can be made with all the important towns in central New York as far east as Utica. Long-distance connections will also be made with Naples through the same toll service.

The Cumberland Valley Telephone Company has been organized and includes the Dauphin County Telephone Company, the Southern Pennsylvania Telephone Company, the Cumberland Valley Telephone and Telegraph Company, the Hanover Telephone Company and the Adams County Telephone Company. The headquarters of this company are to be located in Harrisburg, Pa. Mr. B. S. Myers is the president of the new concern.

The Fall River Automatic Telephone Company, of Fall River, Mass., has commenced operating its exchange with a portion of its subscribers, and is adding to the number as fast as telephones can be put in and connected by the present force of men. New applications for the automatic service are coming in freely on account of the satisfaction given. The Strowger automatic telephone system is used, which is the same system as that installed in New Bedford some months ago. All the latest improvements have been used.

The Standard Telephone Company, of Dubuque, Iowa, has just ordered a large addition to its central office in Dubuque. A few months ago the company installed a large modern switchboard which is now overcrowded and the addition of a 300-drop section has just been ordered which will soon be placed in position in the central station. The company is extending its lines in all directions from that city and will in a few months cover every section of country within a radius of 100 miles of Dubuque.

ELECTRICAL SECURITIES

The week just ended was an extremely quiet one on the New York Stock Exchange. There was considerable liquidation in the minor industrials and prices eased off. The heavy selling of Amalgamated Copper continued, and the price lowered. This company is strong financially, but is supposed to be overstocked.

The United States Steel Corporation stocks have been but little affected by the liquidation in other industrials. The splendid showing of its first six months' business and its action in publishing a detailed statement were leading reasons for its stability. The usual dividends of 1¾ per cent on the preferred and 1 on the common, were declared on Tuesday of last week.

Outside of Wall street the industrial situation is all that could be desired. The reports from the various branches of electrical manufacturing that come to the ELECTRICAL REVIEW are all of one tone—inability to fill orders as fast as desired by customers and output sold ahead for many months.

ELECTRICAL SECURITIES FOR WEEK ENDING OCTOBER 5.

New York:	Closing.
Brooklyn R. T.	60¼
Con. Gas	212¾
Gen. Elec.	250
Man. El.	118¾
Met. St. Ry.	160¼
Kings Co. Elec.	190
N. Y. & N. J. Tel. Co.	165
Telep., Tel. & Cbl. Co.	6

Boston, October 5:	Closing.
Am. Telep. & Tel.	159
Erie Tel.	37
New Eng. Tel.	135
Mass. Elec. pf.	36
Westing. Mfg. pf.	70½
Edison Elec.	250

Philadelphia, October 5:	Closing.
Elec. Co. of America	7
Philadelphia Elec.	5¼
Union Traction	27¼
United G. I. Co.	114
Electric Stor. Bat. c.	63
Elec. Stor. Bat. pf.	63

Chicago, October 8:	Closing.
Chicago Edison Light	160
Central Union Telephone	45
Chicago Telep.	253
Un. Trac.	17
Un. Trac. pf.	58
Metropolitan El	91

MISCELLANEOUS

The Italian Science Society has presented its gold medal to Mr. Marconi for his services in the invention of wireless telegraphy.

The Pennsylvania Telephone Company, at its meeting in Harrisburg, has arranged to issue $1,144,400 worth of stock to acquire the Central Pennsylvania Telephone and Supply Company, a Bell company which has had offices at Williamsport.

It is reported that the Everett-Moore Syndicate is planning to begin operations in Illinois, and that the city of Springfield will be the centre of a big system of suburban railways to be established at an early date. Also that Chicago, St. Louis, Springfield, Decatur and other cities of importance will be connected by electric rail.

The Yesler avenue cable line and the Jackson street electric line, in Seattle, Wash., have been sold at auction to Mr. James S. Goldsmith of that city for $500,000. It is understood that the real purchaser is the Seattle Electric Company, which owns about all of the outstanding bonds and receivers' certificates of these companies.

AUTOMOBILE NOTES

Mr. Charles E. Humphrey has been appointed receiver by the United States Circuit Court for the Woods Motor Vehicle Company, which corporation was organized under the laws of New Jersey, with its principal plants and offices in Chicago.

Arrangements have been made for the establishment in this country of a branch factory of MM. Charron, Girardot & Voigt. A manufacturing plant has been obtained in the vicinity of New York city and the members of the firm hope to have this company's product ready for the spring trade in 1902. American material and American labor only are to be employed and the vehicles are to be built under patents held by MM. Charron, Girardot & Voigt, and are to be particularly adapted to American roads.

Five motor vehicles are to be used in the postal service in Minneapolis, Minn. The vehicles are to weigh not less than 1,000 pounds each, and will be used from January 1, 1902, to June 30, 1903, the running time not to exceed 16 hours a day. The wagons, messengers and electric cars which now carry the mails in the area covered will be supplanted for the time named. This plan is merely an experiment to investigate the feasibility of such a service generally. The vehicles will not be employed for collections.

The performance of the hydro-car and the toledos in the Buffalo endurance contest for automobiles was satisfactory to the American Bicycle Company. All these carriages were standard stock carriages and were unaccompanied by repair wagons, troops and mechanics. They reached Buffalo safely and without being rebuilt on the road. The hydro-car reached Buffalo less than a half hour behind Mr. Bishop's panhard, having left Rochester 15 minutes later. It was the second carriage to reach Buffalo. The two toledos were the first of the steam carriages to arrive.

The accomplishments of the run from London, England, to Reading and back, a distance of 94¾ miles, on one battery charge established the capabilities of electricity as a motive power for automobiles recently. Eight hours were required to cover the distance. The battery utilized was of the Leitner type and was devised about one year ago for this purpose by Mr. Harry Leitner. This record was only one of a number of remarkable runs that were undertaken to prove the efficiency of the battery. On one charge the car has accomplished runs of 70, 80 and 85 miles on other occasions. A total of 1,837 miles was covered by this car during the course of the trials, the units consumed for the purpose amounting to 954.8, and the cost on the average to about three cents per mile. On every occasion the car carried four and sometimes five passengers.

From the tenth to the twenty-fifth of December the fourth annual automobile and cycle show is to be held in Paris. It will doubtless prove as great a success as last year's show. The organizer is the Automobile Club of France together with the Chambre Syndicale de l'Automobile and similar associations of manufacturers. It will be held as before in the Grand Palais of the Champs-Elysees, which affords ample space and good light. The list of rules has just been published. Automobiles, motor-cycles and mechanical traction vehicles form the first class, and cycles of all systems the second. Then comes materials of construction, tires and pneumatics, detached pieces, motors and accumulators, the classes relating to navigation (automobile boats), aerostatics, sports and touring, carriage work, costumes and equipments, inventions, bibliography and photography. Demands for space should be addressed to the Commissariat Générale de l'Exposition, 6 place de la Concorde, before the tenth of October. Special arrangements have been made as to insurance and the handling of inflammable material. Measures to have the objects imported free of duty, provided they are taken back after the exposition, are being made by the commission.

The first annual automobile exhibition, under the auspices of the Chicago Automobile Club and the National Association of Automobile Manufacturers, will be held in the Coliseum Building, Chicago, March 1 to 8, inclusive, 1902. Plans and details are being prepared and will be distributed in the course of a few days. The Coliseum affords ample exhibition space and facilities for this purpose. Its capacity has recently been augmented by the addition of an annex 75 by 175 feet. It was the scene of the first indoor automobile exhibition held in Chicago in March, 1900, when the facilities of the building for an exhibition of this nature were fully tested and satisfactorily met. With the facilities commanded, and the united efforts of the leading automobile club of the West and the manufacturers' association, it is believed that the exhibition will be unqualifiedly successful. Mr. S. A. Miles, who managed last year's exhibition, will assume the general direction of the show which will be instituted on March 1 next, and which it is believed will receive the cordial support of the manufacturing interests of the city of Chicago and general public, assuring an exhibition creditable alike to the trade, the club and to the manufacturers' association.

PERSONAL MENTION

MR. SPOOTTSWOOD GARLAND has been elected president of the People's Railway Company in Wilmington, Del.

HON. H. E. WELLS, of Preston, Minn., is interested in a plan to construct an electric railway from Decorah, Iowa, overland to Chatfield, Minn.

MR. FRANCIS B. DEGRESS now has charge of the New York office of the Crocker-Wheeler Company. Mail for this office should be addressed to the Crocker-Wheeler Company, New York branch, 39 Cortlandt street, New York, N. Y.

MR. JOHN W. MACKAY has been in Washington with the object of making arrangements for the landing privileges of the cables for the new Commercial Pacific Cable Company at San Francisco, the Hawaiian Islands and Manila.

MR. ARCHER HARMAN, managing editor of the Ecuadorian Association, Limited, which British-American capitalist concern is building the Guayaquil & Quito Railway, in Ecuador, S. A., has just returned from a trip to that part of the world.

PROFESSOR YEIJI NAKAJIMA, who is the chief engineer of Tokio, Japan, is now in the United States with the object of studying the principal electric traction systems here, with a view to adopting the American method of double trolleys in Tokio.

MR. W. J. TOOLE, station superintendent of the Glasgow Corporation Electricity Works, will shortly arrive in New York to study American electrical practice. His attention will be devoted principally to inspecting electric traction systems in New York and Pittsburgh.

PROFESSOR E. B. ROSA, of Wesleyan University, Middletown, Ct., who has been recently appointed physicist of the newly formed National Bureau of Standards at Washington, will remain at Middletown during the coming college year, conducting his classes as before. After this year, however, he will make Washington his permanent headquarters. During the present year he will make weekly trips to Washington in order to direct the organization of the Bureau of Standards.

INDUSTRIAL ITEMS

THE HEINE SAFETY BOILER COMPANY, of St. Louis, whose product has gained such favor in this country, reports a very gratifying demand for these boilers in foreign countries. In South Africa, Australia and New Zealand the boilers are especially popular.

THE CENTRAL ELECTRIC COMPANY, of Chicago, will send to any one upon request a full set of bulletins on Pittsburgh transformers, describing in full their electrical and mechanical design, also giving full data on their capacity, core loss, efficiency, etc.

THE SHULTZ BELTING COMPANY, of St. Louis, is making additions to its already large plant which will more than double the capacity of the same. Three new buildings are being constructed, one of which will be 160 by 150 feet and four stories high. The others which will be two stories in height, will be 75 by 40 feet each.

THE CORPORATION OF NEWPORT, England, is at present inviting tenders for the supply and erection of trucks for outside pole handling, piping, switchboards, cables, cable ways, overhead construction, complete electric motor car and repair shop equipments in connection with the city's tramways and power supply.

THE WESTERN ELECTRIC COMPANY, of St. Louis, is pleased with the fall business, as it has so far developed, and expects the season's trade to be strong in all of its departments. This company has recently finished the installation of a complete power and light plant for the Schickle, Harrison & Howard Iron and Steel Company, of St. Louis.

THE COLUMBIA INCANDESCENT LAMP COMPANY, of St. Louis, reports large sales of its well-known Columbia lamps. Usually the months of July and August are the dull months in the lighting business. This year the Columbia company has done the biggest business in its history during those months, and the fall trade promises to be all that the company could desire.

THE CHICAGO RHEOSTAT COMPANY, of New York, is distributing a very neat and attractive booklet describing its motor starting and speed-regulating rheostats, among which are automatic starters, automatic starters with overload cutoff, universal starters. This booklet contains instructions for ordering motor starters and some very neat cuts of the apparatus, also price lists.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, of St. Louis, has a very large exhibit this year at the big Texas state fair which is held at Dallas. Secretary M. E. Martin and Mr. C. H. Wallis, western representatives of the company, are in charge. Business is brisk with this concern and it has recently found it necessary to locate Mr. H. C. Hoover in Atlanta, Ga., as its southeastern representative.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, of New York, is issuing a very attractive folder describing its enclosed arc lamps adapted for any system of electrical distribution, alternating-current lamps, alternating series enclosed arc system, incandescent lamps, knife switches suited to currents up to 20,000 volts, push-button switches, automatic switches, oil switches, high-tension switches and other apparatus.

THE *New York Times*, of New York, N. Y., issued a very fine jubilee number on September 25. The jubilee number was made ready for distribution on the anniversary day, September 18. As the mind and hearts of the people at that time were filled with sorrow and mourning the celebration of the anniversary and the issuance of the jubilee number were postponed one week. It is a story of remarkable interest and one not confined to the events in the life of the *Times*. It tells much about the life of its contemporaries and neighbors and the growth of newspapers in the city of New York.

THE IRON CITY ENGINEERING COMPANY, successor to Fessenden & Ridinger, of Pittsburgh, Pa., within the last month has closed the two following contracts: At Uniontown, Pa., four 150-horse-power tandem compound direct-connected Ball engines; four 100-kilowatt Crocker-Wheeler generators; one six-panel switchboard manufactured by the Crouse-Hinds Electric Company, and conduit and wiring for the 12 floors of the building. At College Hill, Beaver Falls, Pa., a 50-horse-power Walworth gas engine; a 30-kilowatt Warren inductor alternator; a Crouse-Hinds switchboard; 20 Manhattan series alternating-current enclosed arc lamps, and a pole line covering the entire town.

THE STUART-HOWLAND COMPANY, of Boston, Mass., has made much progress in developing its business since it entered the field of electrical supplies and specialties. Since its inception it has been compelled to increase its floor space by about 4,000 feet. It started with two salesmen and now has eight salesmen on the road covering New England, New York, New Jersey, Pennsylvania and the leading cities as far south as Washington. This company carries a very large and complete stock of electric lighting, telephone and street railway supplies. Its inventory showed that it had on hand 48,473 incandescent lamps in over 250 varieties and over 233 tons of cross-arms, braces, bolts, bracket arms and other line material. Within the last six months it has supplied the material for over 400 miles of street railway excepting the wire.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, states that its fall business has opened up in a most satisfactory manner, which is especially true of its apparatus department. The company states that this department has never before been so busy. It is an exclusive agent for the Warren alternator, for alternating-current apparatus, and the Eddy Electric Manufacturing Company's direct-current apparatus. It handles in connection with this apparatus, Moloney transformers and Adams-Bagnall enclosed arc lamps. In connection with its apparatus department, it has a fully equipped engineering department, which is prepared to draw up plans and specifications for lighting plants, and give any information and data necessary for the installation of electric light and power plants. It has a complete line of bulletins and descriptive matter, illustrating this apparatus, which will be sent upon application.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, of Chicago, reports a very satisfactory year in its pole business. The company entered this field about January of the present year and secured from producers in the vicinity of Escanaba, Mich., a very large stock of white cedar poles, with an idea of furnishing the same to telephone companies in connection with its switchboard and telephone business. It furnished a large number of poles for the independent plants at Jackson and Detroit, Mich.; Columbus, Ohio, and also made heavy shipments for the new plants now being constructed at Alliance and Canton, Ohio. Iowa, Indiana, Illinois and the southwestern states also purchased a large proportion of the company's stock. It was of course an experiment for a telephone manufacturing company to enter heavily upon a branch such as the pole business, but the results have been so satisfactory and worked in so well with its general business that it has decided to continue for another year. The stock is not exhausted, and the company would be pleased to quote prices to those in need of this material.

NEW INCORPORATIONS

ALBION, PA.—Albion Telephone Company. $5,500.

HOWELL, MICH.—Livingston Home Telephone Company. $100,000.

CAMDEN, N. J.—Phœnix Gas and Electric Company. $1,000,000.

CRESSON, CAMBRIA COUNTY, PA.—Cambria County Telephone Company. $50,000.

MORRIS, MINN.—Stevens County Telephone Company. $10,000. Incorporators: C. R. C. Johnson, H. L. Hurlburt and others.

BINGHAMTON, N. Y.—Broome County Electric Company. $100,000. Directors: F. J. Sands and D. R. Buckley, of Unadilla, N. Y.

PADUCAH, KY.—Paducah Gas and Electric Company. $125,000. Incorporators: Thomas E. Noss, of Paducah; F. A. Lane and others.

TRENTON, N. J.—American Telegraphine Company. $10,000. To construct and operate telegraph lines. Incorporators: Frank A. Briggs, Trenton, N. J.; E. W. Creecy, Washington, D. C., and others.

GLOVERSVILLE, N. Y.—The Mohawk Valley Power Company. $5,000. To sell power in all the countries along the Mohawk Valley. Directors: Peter E. Garrison, William H. H. Dailey and others.

CLIFTON, ARIZ.—Arizona & New Mexico Telegraph Company. $15,000. To build a telegraph and telephone line from Clifton to Lordsburg and Hachita, either with or without wires. Incorporators: Harwood J. Simmons, Alexander Veitch and others.

MADISON, WIS.—Interurban Telephone Company. $200,000. To construct, operate and maintain a system of telephone lines and exchanges in Wisconsin, and which may be extended outside the state. Incorporators: A. L. Hutchinson, H. E. Kepler and others.

PLEASANTVILLE, N. Y.—Westchester Traction Company. $200,000. To build an electric road five miles long connecting the Ossining Electric Railway at the Methodist camp meeting ground with Pleasantville. Directors: Thomas F. Barrett, Harry M. Shaw and others.

CINCINNATI, OHIO—The Hamilton, Eaton & Richmond Traction Company. $200,000, to be increased to $750,000. This is the central division of the Cincinnati, Hamilton, Richmond & Muncie Traction Company. Mr. John J. Hall, of Dayton, Ohio, is the president.

SENECA FALLS, N. Y.—Seneca Falls Home Telephone Company. $100,000. To operate in Seneca Falls, Tyre and Junius, Seneca County. Directors: Howard Hendrickson, Albany; A. G. Lord, J. A. Drake, S. B. R. Rawson, F. H. Sudro, T. M. Brush, B. W. Martin and J. H. Griswold, of Elyria, Ohio.

INDIANAPOLIS, IND.—Indianapolis, Shelbyville & Southeastern Traction Company. $600,000. To operate an electric line from Indianapolis to New Bethel by way of Acton Park. Directors: Ed. K. Adams, Thomas E. Goodrich, Charles M. Cooper, John R. Messick, Albert DePrez, William N. Harding and Sherman P. Minear.

LANSING, MICH.—Jackson & Ann Arbor Railway Company and Detroit & Ann Arbor Railway Company. Capital of each $100,000. The former proposes to build an electric line from Jackson to Ann Arbor, Mich., and the latter a line from Ann Arbor to Detroit, Mich. Incorporators: Worrall Wilson, Grass Lake, Mich.; Glenn D. Smith, Jackson, Mich., and others.

List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED OCTOBER 1, 1901.

683,432 Apparatus for lighting vehicles by electricity; Benny Bernstein, New York, N. Y.—This is an apparatus for obtaining motion for a dynamo connected with a storage battery from the axle of a vehicle, such as a railway car.

683,444 Circuit-controller; William H. Cowen, New York, N. Y.

683,453 Electromagnet; Edward B. Ellicott, Chicago, Ill.—This electromagnet is of the variety used in telephone and telegraph apparatus.

683,460 System of distribution; William S. Gould, New York, N. Y.—This patent covers one of the modern systems for operating end cell switches in connection with a storage battery system and boosters.

683,480 Supervisory signal for telephone switchboards; Frank R. McBerty and James L. McQuarrie, Chicago, Ill.—This is a supervisory signal adapted for operation in connection with a common battery telephone system.

683,505 Telephone circuit; Charles E. Scribner, Chicago, Ill.—In this somewhat elaborate specification, Mr.

(Continued on page 53)

WANTED

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PATENTS.

(Continued from page 51.)

Scribner describes a system whereby a number of transmitters may be simultaneously supplied with current from a common battery, while at the same time the independence of their various telephonic circuits is preserved.

683,521 Anchor for pipes of conduits; Louis Teuscher, La Porte, Ind.

683,584 Trolley; E. A. Wakefield, Pelham, Mass.—This invention consists of a single standard carrying two trolleys, one of which is fastened down upon the roof of the car, while the other engages with the wire.

683,558. Manufacture and repair of incandescent lamps; Ferdinand Fanta, London, England—This is a patent for a method of reflashing filaments in lamps which have become deteriorated.

683,569 Automatic signaling system for telephone exchanges; James L. McQuarrie, Chicago, Ill.—This patent describes an automatic ringing apparatus for use in large central exchanges.

683,579 Cutout block; H. O. Swoboda, New York, N. Y.

683,501 Electric brake; E. A. Henry, Crestline, Kan.

(Concluded on page 54.)

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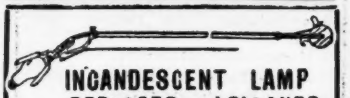

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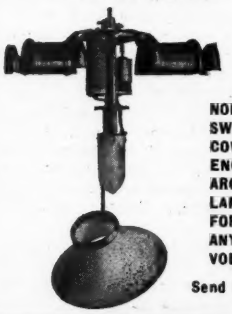

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PATENTS.

(Concluded from page 52.)

583,622 Electrical measuring instrument; H. O. Rugh, Sandwich, Ill.—The instrument is of the type known as an ohmmeter, in which the two branches of a Wheatstone bridge are formed by a length of high resistance wire, which is tapped by a hand-operated contact-maker, sounds in the telephone connected with the system showing when the zero point is reached.

683,631 Telephone receiver; H. L. White, Utica, N. Y.—This patent describes a bipolar telephone receiver.

683,639 Conductive appliance; W. P. Crocket, Chicago, Ill.

683,668 Electrical measuring instrument; Nathan H. Surem, Needham, Mass.—This is a volt or ampere meter of the permanent magnet class.

683,759 Electric signaling apparatus; F. B. Herzog and S. S. Wheeler, New York, N. Y.

683,831 Electric meter; the Archioni Spoleto.

683,872 Electrical signaling apparatus; Alfred U. Alcock, London, England.

683,876 Gas-lighter; S. Boronow, New York, N. Y.—This instrument works by the incandescence of a fine platinum wire.

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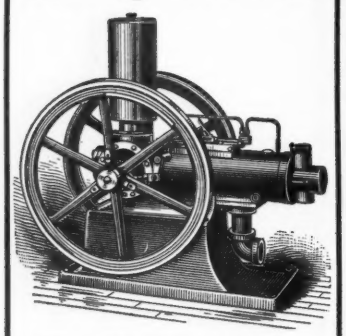

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